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Oakland Avenue Reinforced-Concrete Bridge in Piedmont, California.

By W. P. DAY,* Assoc. M. Am. Soc. C. E.

A reinforced-concrete bridge on Oakland Ave., in the city of Piedmont, California, has just been completed and opened for traffic. Some of the features of this structure are out of the ordinary, and may prove of interest to the profession. The necessity for a bridge originated in the minds of the Board of Trustees of the city of Piedmont, and the members of the Board invited four engineers to submit plans in competition, furnishing each with a profile of the crossing and elementary foundation data prepared by the County Engineer. The plans of Mr. Jno. B. Leonard, of San Francisco, were chosen by the Board and by the engineers employed to pass upon the stability of all designs submitted.

It was the express desire of the Trustees that the city be given something out of the ordinary, and it was with this idea in mind that the successful plans were prepared. The old Mission type of architecture was followed, a unique feature in bridge work being the introduction of four intermediate kiosks or resting places, supported by light concrete columns, and roofed in the regulation manner with Spanish S tile. The portals offered another opportunity for architectural treatment, and the result is four huge pylons at either end, capped with a decorative feature cast in concrete, the latter enclosing large ornamental lights (Fig. 1).

The total length of the structure is 362 ft. 10 ins., including a central arch span of 130 ft. in the clear and symmetrical approaches. The latter are composed of reinforced slabs supported by girders and columns, all enclosed in 6-in. exterior curtain walls. Each transverse bent is made up of three columns. The roadway is 22 ft. wide, with an additional 6-ft. sidewalk on either side. The intrados curve of the arch was chosen for beauty, as well as economy. The rib was analyzed by the elastic theory, and both temperature and rib shortening were provided for. The slab of the approaches, and the arch, were designed to carry an interurban electric car, and the sidewalks were designed for a live load of 150 lbs. per sq. ft., carried by ornamental brackets rigidly connected to the arch rib and approach slabs.

The site was occupied by a timber trestle, and preparations for the removal of this structure began July 19, 1910. There were approximately 40,000 ft. of lumber in the trestle, the major portion of which was used for shoring and centering for the new bridge. The excavation in both abutment pits was made with teams, slips, and plows encountering good firm clay and occasional gravel, with but little moisture. This work was done for about 50 cts. per cu. yd., paying $5 per day for teams and $2 per day to laborers.

Standard cement from Davenport, Cal., was used for all concrete, and the rock was a blue trap from a quarry near the site. The concrete in the bases of the piers was run for about 60 cts. per cu. yd. on the basis of $4 per day to concrete men.

The falsework of the arch was made of 8 × 10-in., 8 × 12-in. and 10 × 12-in. stock (Fig. 3). The bents were on approximately 5 ft. centers, and the posts of each bent on 6-ft. centers. The posts were placed normal to the intrados curve, as shown in Fig. 1, and were supported on continuous sills firmly embedded in the soil. The falsework was unusually heavy and clumsy, but the timber from the trestle was old and its strength could only be guessed at. Heavy caps were placed transversely on each bent, the caps

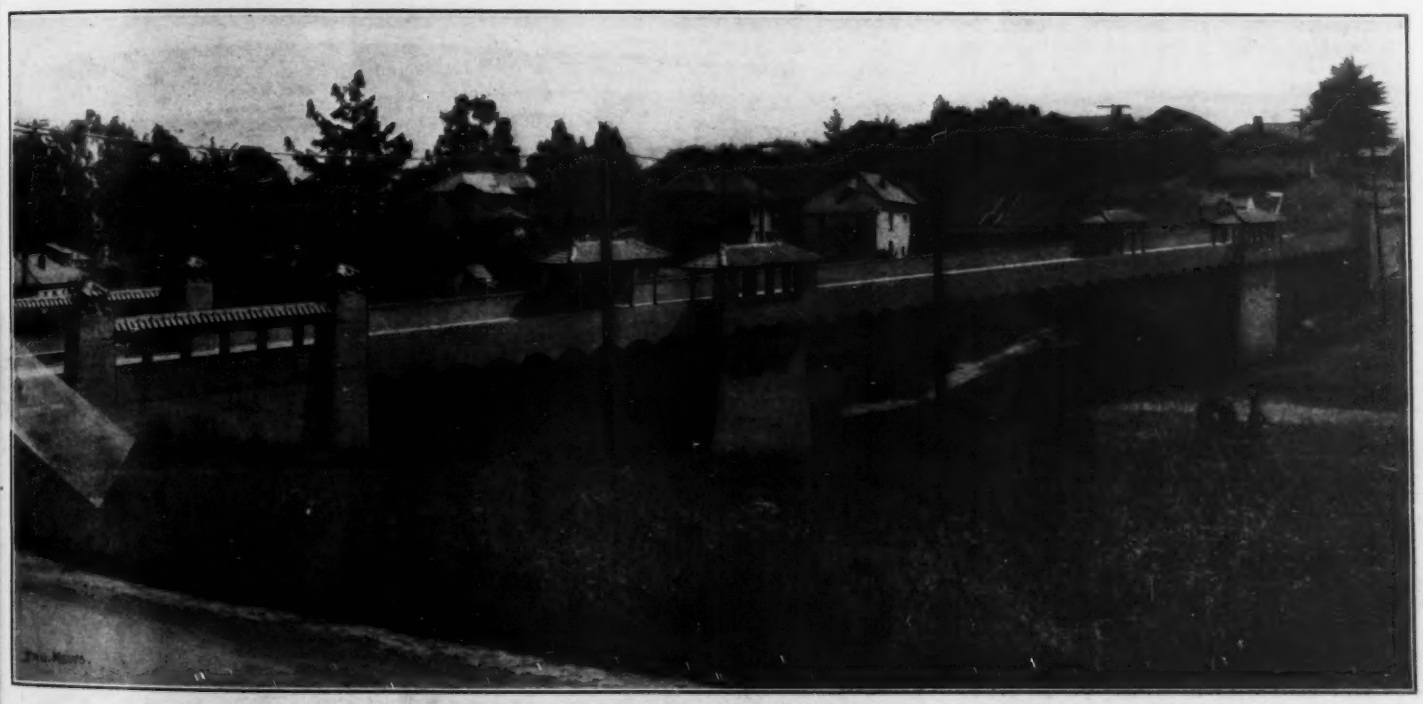


FIG. 1. THE OAKLAND AVE. BRIDGE, PIEDMONT, CAL.; A REINFORCED-CONCRETE BRIDGE IN MISSION ARCHITECTURE.
(J. B. Leonard, Engineer; A. A. Farr, Architect.)

*Civil Engineer, 315 Sheldon Bldg., San Francisco, Cal.

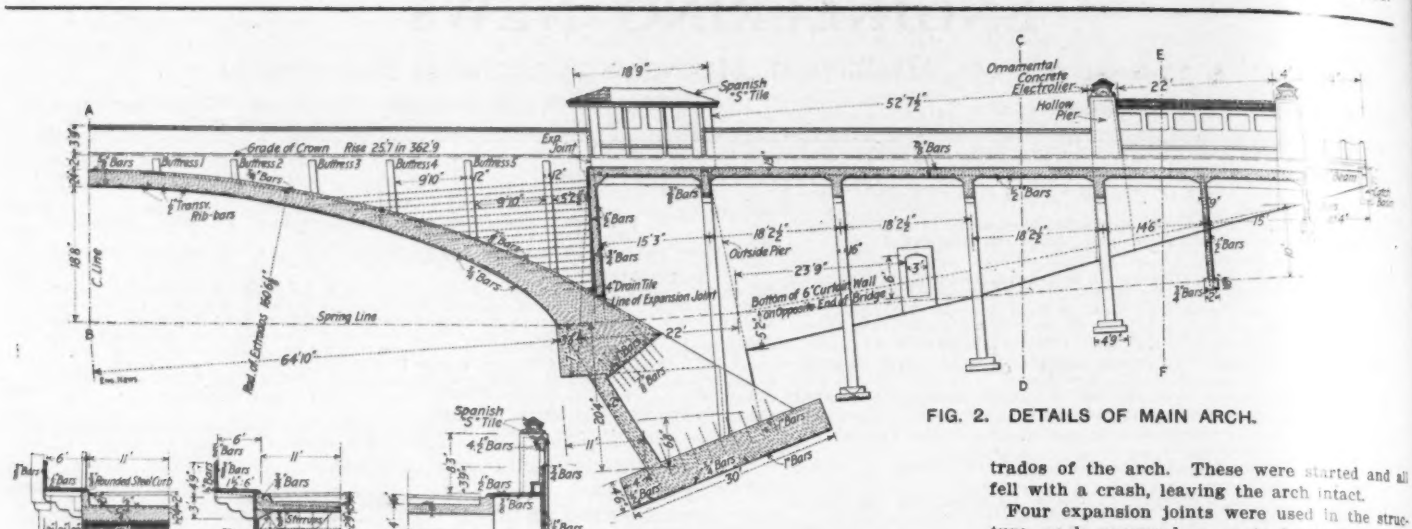
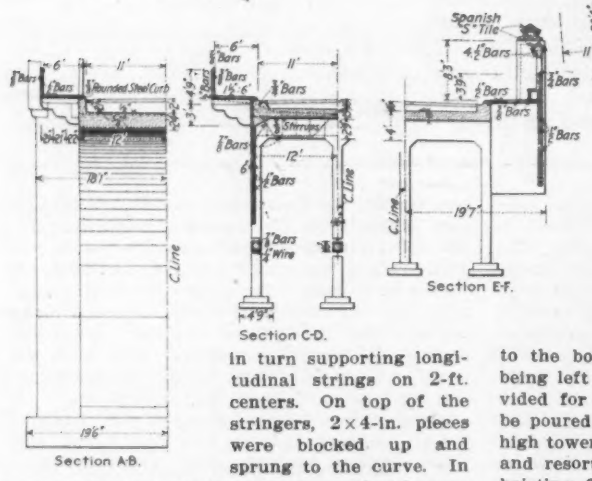


FIG. 2. DETAILS OF MAIN ARCH.



in turn supporting longitudinal strings on 2-ft. centers. On top of the stringers, 2×4-in. pieces were blocked up and sprung to the curve. In some portions of the intrados curve, that is near the haunches, where the curvature is great, 2 × 4-in. stock could not be sprung without splitting, and use was made of two pieces of 1 × 6-in. nailed together. These readily took the desired spring, and the variation from the true curve was practically nil when the decking was finally placed. Constant wetting down (sometimes four times daily) kept the decking in excellent condition. Points on the intrados curve, near the crown, were built ¼-in. higher than required to allow for settlement in the foundation of the falsework. Passage for a roadway below was maintained by an A-frame.

The concrete of the rib was poured through timber chutes leading from a hoist at the center (Fig. 4). Doors in the chute were provided in case the concrete flowed too rapidly, and separated the coarser from the finer components. Their use, however, was found unnecessary, the pitch of the chute being a minimum. When the arch was ready for casting, concrete was poured equally on the two haunches from morning until 5 p. m. It was allowed to stand from 5 p. m. until 10 p. m., work then being resumed until 2 a. m. The following morning at 8 o'clock the pouring was continued. An attempt was made to take out some of the shrinkage, without allowing the concrete to set too hard. Inclined shear rods were placed in the concrete on stopping each pour, as a precaution against failure by horizontal shear. On the completion of the casting, and for several days thereafter, the arch was wet down four times daily. The usual bucking of the forms at the crown, after pouring the haunches, did not occur owing to the inclination of the posts. The falsework remained under the rib for about six weeks. The writer deemed it proper to strike centers before the spandrel wall forms were set in place, so as to allow the arch to take its unconstrained shape, without subjecting the walls to the consequent stress.

As shown in the details, the approaches are symmetrical, each being a 15-in. reinforced slab supported on transverse girders. The forms were made in the regulation way, and no difficulties were encountered. The entire lower approach was poured through a chute, the length of the latter from the hoist over the mixer being 180 ft. The chute was 18 ins. wide and 10 ins. deep, and had a drop of 2½ ins. per foot. Running the mix a little wet produced a perfect concrete at the extreme end. On account of the depth of the girders they were poured in two parts, 4 × 12-in. blocks, and ⅝-in. rods being used to provide for horizontal shear at the plane where the work was stopped. All of the side walls were poured to the bottom of the sidewalk, a dap of 1 in. being left for each bracket and anchor rods provided for each. The upper approach could not be poured by the chute, without building a very high tower, on account of the grade of the bridge, and resort was made to the regulation buggies, hoisting first from the mixer to a runway over the arch.

As work on the concrete progressed, experiments were made on it at different ages, with a view to determining the advisability of hand picking the surface in place of sand blasting, the specifications calling for the latter, and for the "entire removal of the lines of the forms, leaving a uniform rough appearance." The hand picking did not produce as desirable a surface as the sand blasting, and the latter was decided upon.

FIG. 3. VIEW OF MAIN ARCH DURING CONSTRUCTION, SHOWING FALSEWORK POSTS RADIAL TO THE INTRADOS.

Preparatory to striking the arch all of the transverse and longitudinal bracing, and the A-frame at the center were removed. The posts were then loosened by moving the bottom of each laterally with a sledge hammer. Each inclined post was moved slightly three different times, and the vertical posts were dropped a saw cut. Finally all were free, and were removed, the decking, stringers and caps clinging to the intrados of the arch. These were started and all fell with a crash, leaving the arch intact.

Four expansion joints were used in the structure, each arranged so as to be hidden by the piers. The use of asphalt was originally contemplated, but was replaced by two thicknesses of heavy felt. Little or no dirt can penetrate the joint, and it is believed that a better working joint has been obtained than would have been produced by the asphalted joint, the material of which would expand and contract with variations in temperature.

The spandrel walls were 12 ins. thick, reinforced horizontally, and held at regular intervals by buttresses tied directly to the rib. Before beginning the back fill, the joint between the spandrel walls and the rib was thoroughly mopped over with asphalt, the object being to prevent the usual efflorescence on the outside along the line of the extrados curve. Complete success did not attend this effort, although the seepage and consequent efflorescence is gradually disappearing. The writer believes that there is considerable room for improvement over the usual methods for constructing the joint between the side walls and the rib in spandrel filled arches. It appears to be necessary to show a construction line here, unless impracticable methods of erection are pursued. It remains to so construct this as to at least obtain a uniform line, rather than the rough and broken line so often seen.

The back fill was made in the following manner: An inclined runway was built from the ground over the railing of the sidewalk, and supported at the high end on the rib. A donkey engine, Fresno scraper and cable were manipulated by four men, including the engineer and fire tender. When half of the high end was

filled another runway was built at the lower end of the arch, and the donkey engine moved there. The lower end was then completed, when the outfit was again moved to the high end, and the entire fill completed. Undue eccentricity of loading was thereby avoided. Continual wetting and tamping produced a well packed fill, although a little settlement has since taken place. The Board of Trustees have been advised to allow the fill to pack itself securely for several months before an attempt is made to place a macadam roadway on it. The contract for the construction of the bridge did not include the wearing surface for the fill.

Sand blasting was begun on the intrados of the arch. The general contractor sublet this work for $500; the surface to be blasted was approximately 3,200 sq. yds. The subcontractor soon realized his inability to carry out his contract for this figure, and the work was completed by the general contractor. He immediately installed two motors of 40 and 30 HP., respectively, and two compressors. He rigged up to feed one boiler with two compressors, and provided two sand tanks. From the boiler to the water settling reservoir, 1-in. pipes were used, and from the reservoir ¾-in. pipes led to nozzles, with intermediate valves for the sand tanks, all arranged

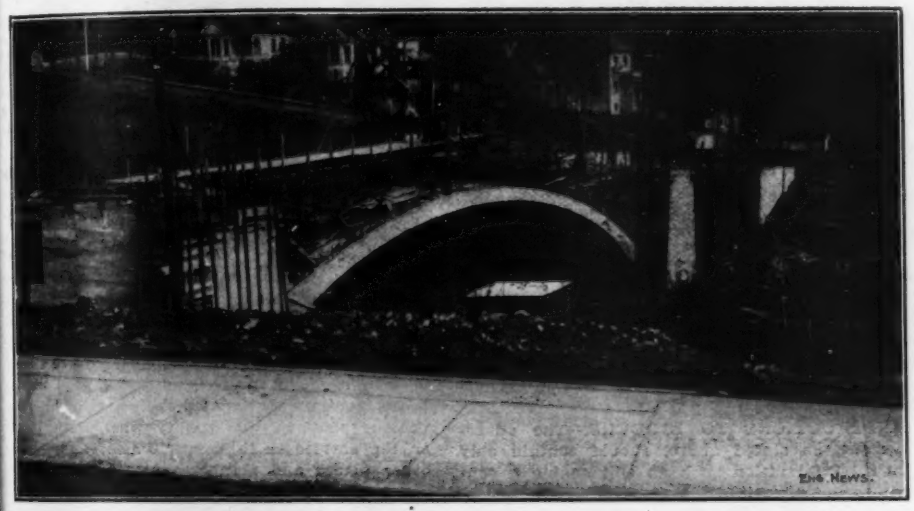


FIG. 4. THE OAKLAND AVE. BRIDGE DURING CONSTRUCTION, SHOWING METHOD OF DEPOSITING CONCRETE.

so that both nozzles could be fed from either sand tank. In consequence there was no time lost for filling sand tanks. During the latter portion of the work three ¼-in. nozzles were used, one from a ¾-in. and two from a 1-in. pipe. The average pressure at the nozzle was 100 lbs. per sq. in., the blow-off being fixed at 120 lbs. per sq. in. The writer's experience on this structure showed that best results in sand-blasting are obtained on concrete about three weeks old, dependent, of course, on the climate, using a ¼-in. nozzle held about a foot from the surface to be blasted, and a pressure of about 100 lbs. per sq. in. Care must also be used in the proportioning of the concrete. Lack of uniformity will show distinctly in the blasted surface, but with proper precautions an extremely pleasing result may be obtained.

A comparison of the deflections in the rib, by actual measurements with those obtained by computation, proved of considerable interest. Measurements were taken with a precision level, and a Philadelphia rod on five points, one above each springing line, one on the crown and one at each haunch.

The first readings on these points were taken just before striking the centers, and the second set of readings just after striking centers. The drop in each case was as follows: No. 1, 0.021 ft.; No. 2, 0.036 ft.; No. 3, 0.074 ft.; No. 4, 0.047 ft.; No. 5, 0.023 ft.

The apparatus for measuring horizontal deflections was interfered with on striking centers. The arch, however, and abutments were so built the arch manifested itself in a gradual parting of the joint, the total opening reaching ⅛-in. There has been no appreciable change since.

Approximately 2,250 cu. yds. of concrete, and 80 tons of steel, were placed in this structure, and the contract price was $30,550, including electroliers. The average cost of the aggregate was $1.60 per cu. yd., and of the cement $2 per bbl. The cost of placing the steel averaged $9 per ton, assuming $5 per day to the housesmiths. The total cost of labor, including carpenters, concrete men, laborers, housesmiths and teams, was about $13,500. This figure is somewhat high owing to the comparatively great amount of carpentry work for this type of bridge. The entire structure is on a 7% grade, and the lines of all brackets follow the grade. The structure was erected by the Rickon-Ehrhart Co., of San Francisco; the engineer was Mr. Jno. B. Leonard, and the architect Mr. Albert A. Farr.

Electrical Resistance of Metals at the temperature of liquid helium has been investigated by Mr. H. K. Onnes, the results being published in the Proceeding of the Koninklijke Akademie van Wetenschappen, of Amsterdam, and reprinted in the London "Electrician" of Aug. 4. A mercury resistance had a value of 172.7 ohms liquid at 0° C. or an exterpolated value of 39.7 ohms for solid mercury for that temperature. At 4.3° K this had fallen to 0.084 ohms; at 3° K it was 3 × 10.6 and at 1.5° K it remained at that figure—one ten millionth the equivalent value of solid mercury at 0° C. (K indicates the Krypton gas thermometer.)

Dried Bagasse as Fuel.

The Agricultural Experiment Station of the Louisiana State University for a long time past has been studying the use of refuse sugar cane, or bagasse, as a boiler fuel, and has done much to promote the most economical disposal of this waste product. On account of its great content of water (52 to 55%) and its bulk, compared with coal, oil and wood, special furnace construction is resorted to—oftentimes with oil firing as an auxiliary operation. Some of these boiler plants have been more successful as bagasse consumers than as economical steam generators; to the remedying of such conditions the Experiment Station has been giving much attention, through Prof. E. W. Kerr, of the Mechanical Engineering Department, and his assistants.

Bulletin 128 of the Louisiana Experiment Station describes the work done in reducing the moisture content of bagasse by passing it through the hot flue gases. This bulletin has been drawn on for the following notes.

In approaching the problem of developing drying processes two schemes were presented: (1) an indirect method of heating fresh air and passing it through or over the bagasse, and (2) passing the flue gases directly to the refuse. It was found by computation that the combustion of ordinary wet bagasse gave only 0.79 lb. of water to 5.19 lbs. of flue gases. These flue gases, even when cooled down to 212° F., had a moisture-carrying capacity of 8.23 lbs. It was then seen that there was no fear of recondensation of moisture upon the fresh bagasse which would have to be regularly introduced into any dryer, and that the direct scheme was feasible from that point of view.

To see if the bagasse could be dried in the hot flue gases without danger of catching on fire, samples of the moist refuse were placed in wire baskets and hung in the smokebox of a boiler. Some 12 minutes exposure was possible before the material began to burn. It was not expected that the refuse would have to be exposed this long and so the construction of an experimental direct dryer was decided on.

This apparatus consisted essentially of a tower 4 × 6 ft. in cross section and 20 ft. high, built of steel plate and angle iron. The flue gases entered at the bottom and left at the top, through special openings. The bagasse entered at the top though an air lock and was received upon the first of a series of inclined and mechanically rocked shelves. These shelves were all hinged on one side of the tower and between them a second series was similarly placed but hinged on the opposite side of the tower. The bagasse charges traveled downward from shelf to shelf, as the rocking frames were worked, the transit from top to bottom in contact with the hot flue gases taking about a minute. The dried material was caught at the bottom in galvanized buckets, in an air-locked hopper, and later elevated to the furnace of the boilers, where it was used for fuel. A fan was used to increase draft through the dryer and boilers.

Careful tests, extending over a month and more, with wet and dried refuse fuel, showed that the bagasse lost approximately 15% of its weight in going through the dryer. The increase in fuel value due to drying was 32%. It was found that there was an additional gain due to better combustion with the dried than the wet refuse. The average furnace temperature with wet bagasse fuel was 1503° F., while with the dried material it was 1644°.

This dryer was designed to work with a 100-HP. boiler, and the weight dried varied between 686 and 3,155 lbs. per hour, as limits. It was believed that it would treat fuel to develop 125 or 150 HP. The cost of the dryer was $1,000, with fan and other accessories, except the auxiliary engine. The cost of a dryer of this type for a factory of 1,000 tons per day (24 hours) capacity, is estimated at $5,000 to $6,000. One extra man would be required for it. The oil fuel saved by this preliminary drying for such a 1,000-ton plant, at $1 per bbl., would amount to $3,670 per year.

The Requirements and Theory of the Advertisement or Notice to Bidders on Contracts for Public Works.

By JEROME COCHRAN, C. E., M. C. E.*

The following article was written with the idea of placing before engineers the fundamental principles underlying the general requirements of advertising for bids on public works contracts. The article is made as compact and general as possible, and the requirements are applicable to all classes of construction work.

General Requirements.

All the necessary preliminary preparations for the construction of a public work having been completed, the next step—assuming that the work is to be done by contract—will be to ask for proposals from contractors. Proposals are usually invited by advertising to that effect in the public press and technical periodicals of both national and local circulation devoted to the special class of work involved, so as to reach all the persons or firms likely to bid on such work.

OBJECT OF ADVERTISING.—The object of advertising is to bring into active competition all those who may be interested in and capable of performing a certain kind of work; hence, it should be done in such manner and localities as to reach the greatest number of bidders. Liberal advertising should be required for all public works contracts, for the great temptation on the part of many is to keep bidding at home, and encourage home industries. This generally results in poor economy by allowing a contractors' ring to be formed, thereby letting practically all contracts at abnormally high figures.

PREPARATION.—The preparation of the advertisement or notice to bidders is not so simple a matter as might, at first thought, be supposed. Such advertisements may be divided into two general classes. The first class merely states that proposals for a certain work will be received up to a stated date and hour, and that plans and specifications may be seen, and bidding blanks and necessary information obtained, at a given address. That is to say, the advertisement is limited to a very brief statement of the class of work or materials wanted, telling where plans and specifications can be obtained. The form of advertising for bids used by the Corps of Engineers of the Army is of this class, as it does not go into the details of the work. The other class of advertisement gives in more or less detail the general character of the work to be done, the approximate quantities of the more important items, the time within which the work must be completed, and the amount and character of the certified check and bond required. Advertisements for the Navy Department are usually of this class; also those for municipal and county work.

REQUIREMENTS GOVERNING PUBLIC WORKS.—All public works, whether for the federal government, one of the states, a city, county, or borough, are generally required by law to be advertised for a certain length of time and to a certain extent before letting. In other words, the law requires that officials give timely notice to all likely bidders by public advertising, when any particular line of work or commodity is called for. In some instances, particular newspapers are mentioned, but generally those having the widest circulation are selected for advertising. It will be expedient for the engineer to inform himself as to the local requirements on this point before closing his contract, as legal objections have been sustained to contracts on the grounds that they were not properly advertised.

WHAT THE ADVERTISEMENT SHOULD CONTAIN.—The advertisement should be as short as possible to contain the necessary information, for where such public notices are much expanded and inserted in few papers, it generally indicates a desire on the part of the official to make advertising expensive, and hence decrease its amount and the chances for competition, at the same time giving unnecessary pay to some favorite paper. In other words, the advertisement should be concisely worded, and yet be sufficiently explicit as to the information required by persons desiring to bid, to prevent unnecessary delay. It should exhibit, when practicable, the requisite information on the following subjects:

(1) A title indicating the kind of work, material or service required.

(2) Place where the labor is to be performed or the goods delivered.

(3) Date and hour at which bids will be opened.

(4) Where further information may be secured.

(5) Name and address of the person, company, or corporation proposing to have the work done.

(6) An adequate description of the work, with special reference to the magnitude of the undertaking and approximate amount (or cost).

(7) If it be public work, the attention of the bidders should be invited to the act of Congress or of the legislature, or to the ordinance, under which, or by virtue of which, the work is undertaken, authorized, or by which it is controlled.

(8) When and where plans, specifications and blank proposals may be obtained, or the work itself may be inspected.

(9) How bids are to be addressed and delivered.

(10) Amount of cash, or of certified check, or guaranty bond required to accompany the bid.

(11) Bond required for the faithful and complete performance of the contract.

(12) Time required for the completion of the work.

(13) Conditions of payment, if these are peculiar.

(14) Whether or not the lowest bid will be accepted without reserve.

(15) A reservation of the right to reject any or all bids.

(16) Any general conditions or instructions with which bidders are expected to comply, as the letting of the work in parts or as a whole; bids to be received from experienced contractors, etc., with any suggestions that may be deemed necessary.

INSTRUCTIONS TO BIDDERS.—The advertisement, as stated above, should contain only general information such as will enable a contractor to determine if he would like to undertake the work. The fuller information enables the non-resident contractor to judge of the character and magnitude of the work involved, whether it is within his capacity to execute the work in the time named, whether he can furnish bond, and has time to make a careful estimate, and finally, whether he cares to compete for and undertake work offered by the parties, and under the supervision of the engineer or architect named. These facts determined, the contractor will apply for and receive full instructions for bidders.

All of the instructions to bidders need not be published as a part of the public advertisement, but should be printed upon the blanks delivered to bidders, as they form a part of the requirements of the contract. In advertising for bids on War Department work these instructions are given quite fully in the specifications. In municipal and county work the advertisements and the instructions to bidders are generally sent out separately.

INVITATION TO CONTRACTORS TO MAKE PROPOSALS.—It is customary for consulting engineers and cities having much work contemplated to issue invitations to contractors to make proposals, so that should they fail to see the advertisement in the newspapers, or other medium, they will have been notified. Invitations are also issued to a selected number of contractors who are in a position to handle the proposed work efficiently. It is generally cheaper to send out a standard form of Invitation or Notice to Bidders than to carry on extensive advertising, although the law requires in most cases that all proposals for public work must be so advertised as to reach the greatest number of contractors.

The Theory of Advertisements.

AS REGARDS THE ADVERTISING MEDIUM.—The act or charter of most public organizations requires that the work to be advertised and proposals solicited from the public. This should be done primarily by advertisements in newspapers and engineering periodicals devoted to the special class of work involved. Small purchases need not be advertised in the papers, but no public money should be spent without at least three bids having been obtained, and all who wish to bid on any particular class of articles should be given an opportunity to do so. Small contracts are usually sufficiently advertised in local papers, but the notices to contractors should appear in practically all of them.

If an advertisement or notice to bidders appears in one daily paper and not in another, many contractors may not see it. Moreover, as the policy of too many papers is more or less influenced by whether or not they get the advertisements, it would be better to limit the advertisement to a brief statement of the class of work or materials wanted, date and hour of opening of bids, where plans and specifications may be seen and bidding blanks and necessary information obtained, and require the notices to be published in every local daily paper. The saving due to even a single extra bid on one small contract will often more than pay for a year of such advertisements. Large contracts should invariably be advertised in the weekly technical journals devoted to the special class of work involved, especially those which make a specialty of keeping contractors posted on pending work.

FRAUDULENT CONTRACTS.—In practically every case of fraudulent contracting, the advertising is invariably kept at a minimum and generally no pretense is made of keeping an office list of contractors. In order to guard against such practice, the engineer should be required to promptly furnish to any one who asks it, full information as to the advertising of any contracts, past, present or future. Every advertisement for a contract of a public nature should be published by posters affixed on a bulletin-board at some designated, permanent and convenient place of the locality wherein the work or the service is to be performed; and in any other places and manner that may seem fit in order to secure as large a competition as possible from responsible bidders. The reason for this is obvious.

AMPLE TIME FOR BIDS.—The right to bid implies the right to know a sufficient time in advance to properly prepare a bid, and ample time should be allowed between the date of publication of the advertisement and that upon which bids are to be opened, to enable the most distant contractor in the State time to investigate the locality and the work, collect the data necessary to submit an intelligent and well-considered proposal, and to make such preliminary arrangements for capital and plant as prudence may dictate.

To prescribe arbitrarily, by law or otherwise, how long each contract shall be advertised is unfortunately a difficult matter. The time necessary will, of course, depend upon the character and magnitude of the work and other conditions, and the engineer in charge will be able to determine the proper limit, provided he is not, as in a great many instances, unduly pressed to shorten the period by impatient city officials. If sufficient time is not allowed, which is generally the case, any contractor should have the right to enjoin the opening of proposals till such time has elapsed as the court decides is sufficient.

The honest engineer frequently finds it is to the best interest of his clients to get the work started in a hurry, even at a greater cost; and the dishonest one can take advantage of the same considerations with comparative safety because of the difficulty any one will have in impugning his judgment. The minimum period of advertising for public work should be arbitrarily fixed by law—longer periods being required for larger contracts. Proposals for contracting for the

*Designing Engineer Trussed Concrete Steel Co., Detroit, Mich.

execution of public work, or furnishing materials, or for any service relating to public works are generally advertised for 30 days. This term is sometimes reduced in urgent cases, but should never be less than 10 days.

SEALED PROPOSALS.—It is generally announced that the bids or proposals which are to be submitted shall be sealed, with the implied understanding that these seals are not to be broken until the bids are opened at the place, date and hour named. This is for the purpose of preventing fraud. However, bids have been steamed open by office employees, and the figures given to rival bidders. To avoid this, every bid should be enclosed in two envelopes, the inner sealed with wax and the outer not showing that a bid is enclosed.

DATE OF OPENING BIDS.—The advertisement usually states at what hour the bids will be accepted. Whenever bids are advertised for they should be opened at the time mentioned, and no proposals for public work should be admitted after the time named has expired, and those received should be opened immediately after the expiration of that time. Unless this be done, suspicious bidders may have opportunity, if not cause, to charge that the delay is for improper purposes. For the bids may all be in and the hour past when some friend of the man running the affair comes along and wants to hand in a bid, and even though it be too late, according to the advertisement, the bid will be accepted for consideration.

MANNER OF OPENING BIDS.—It is customary to state in the advertisement that bids or proposals will be opened in the presence of the bidders; in other words, at an open meeting of the board, committee, corporation, or council. Bidders are invited to be present at this meeting, and to hear the bids publicly read, with the privilege of taking down the prices named, if they choose. Municipal bids should always be opened and read in public, and recorded in a book kept for the purpose by an official clerk. The public should always have the right to inspect the bids at the opening.

Bids are also opened privately, and the results announced after a decision has been rendered upon due consideration of the parties interested. There is no law to govern on private work, for the private individuals, companies, and corporations can do as they please.

If the bids are not opened until the time set for reading them, there can be no harm in admitting a late bidder if the board and all the other bidders consent. In such cases, however, the time limit for receipt of bids should be the time of opening bids, and no bids should be received after any bid has been opened under any consideration.

MANNER OF LETTING CONTRACT.—The advertisement should also state whether or not the work is to be let in parts or only as a whole. If it may be let in parts, the advertisement should indicate by all means what the lines of division are, so that one may know what parts he is at liberty to bid upon.

PAYMENTS.—It is customary to pay for contract work on monthly estimates of the engineer, reserving from each month's estimate of the worth of materials furnished and work done 10% to 20% until final completion. This enables the contractor to carry out the work without having the requisite capital to complete the work with his own means. If the conditions of payment are to be other than this, thus making them unusual and peculiar, such conditions should be stated in the advertisement.

FULL INFORMATION AS TO THE WORK.—The description of the work included in the advertisement should be sufficient to enable the contractor to determine the amount of work embraced in each contract, the time within which it is to be completed, the manner in which it is to be done, and the quality of the materials to be furnished, as well as the approximate cost of the same, and the amount of capital required to successfully prosecute it. In other words, full information should be given to bidders which will enable them to bid intelligently.

RESTRICTIONS EXCLUDING CERTAIN PERSONS FROM BIDDING.—Advertisements for bids for large work quite often have restrictions in them as to who the bidder may be, requiring him to have a certain amount of experience. This is especially the case with reinforced-concrete building construction where five years of experience is sometimes required. In a great many cases, if work was let out to inexperienced firms, poor work would no doubt result.

Exclusion clauses are often put in to shut out certain bidders and contractors who have not completed contracts on time for pieces of work for the same advertiser. Again, if it is known that in any way a man has played crooked with his former employer, an exclusion clause will often be put in, so worded as to exclude him from the right to bid. Such a clause generally reads as follows: "No person is eligible as a bidder who has within two years prior to the letting of this contract made default in payment for any work or labor performed, or any skill or material furnished pursuant to any such contract as herein advertised, or who within said two years failed to complete any such contracts. In cases of failure to accept work for which they are low bidders, contractors on city work in some localities are not allowed to bid again for a year or two."

The reasonableness of a restriction which denies certain persons the privilege of bidding is not so apparent, for it renders it possible for the parties having the power to award the contract to foster favoritism by excluding experienced as well as inexperienced persons who have been so unfortunate as to have differences with public officers. A clause that provides that bids from "any person or firm who are in arrears to the city upon debt or contract, or who is in default as surety upon any obligation to the city, will not be received," or that "proposals from parties who are not known to be regularly and practically engaged in the class of work called for by the drawings and specifications will not be accepted," must give to some one the determination of these questions. If an official is inclined to be very exacting or officious, questions as to his fairness will certainly be raised.

CERTIFIED CHECKS.—The requirement of a certified check to be deposited with the bid is one to save the corporation from the expense and delay of re-advertising, if the accepted bidder fails to enter into the contract, and is intended to be retained to reimburse the city for such damage and expense. That is to say, should the successful bidder fail or refuse to execute a formal bond or contract within the required number of days after the same is sent, his certified check may be declared forfeited, the letter of acceptance of his proposal may be revoked, and all obligations in connection therewith will be released and annulled.

The checks are held in trust for the bidders and the corporation by the officer named to receive them, and are subject to the order of the board until all the conditions of the advertisement and board rules are complied with, when they become the property of the bidders, or of the corporation, according to whether or not the bidders have individually complied with the conditions of the letting.

The certified check or money should not be inclosed in the envelope containing the bid or estimate, but should be either inclosed in a separate envelope addressed to the party wishing bids, or submitted personally upon the presentation of the bid or estimate.

After the contract has been signed and the bond approved, the certified checks should be returned to their respective makers, or if the contract is not awarded within two weeks from the date of opening the bids, the obligation of the bidders should cease and their checks be returned.

Neither the principal or sureties on any bid should have the right to withdraw or cancel the same until the proper authorities have let the contract for which such bid is made, and the same has been duly executed.

If the letting is deferred any bidder can probably demand the return of his certified check, but he at the same time loses his chance to obtain the contract. This is frequently a question of damage to bidders which must be settled upon the merits of the particular case. If the letting is deferred for a considerable time, recourse must be had to the courts. Strictly speaking, the board cannot defer the letting except by consent of the bidders, and cannot usually retain the bids or checks of those unwilling to wait.

BIDDER'S BOND AND SURETY.—The advertisement should require that "each bid or estimate shall be accompanied by the consent in writing of the persons so named, with their respective places of business or residence, to the effect that:

(a) If the contract be awarded to the person making the estimate, they will, upon its being so awarded, become bound as his sureties for its faithful performance.

(b) If he shall omit or refuse to execute the same, they will pay to the corporation any difference between the sum which he would be obliged to pay to the person to whom the contract may be awarded at any subsequent letting, the amount to be calculated upon the estimated amount of the work by which the bids are tested.

It is customary to require that the consent of sureties be accompanied by the oath or affirmation in writing of each of the persons signing the bond or bonds, that he is a householder or freeholder in the state where the proposed work is to be executed, and is the owner of property in value equal to the amount of the surety required for the faithful execution of the contract, over and above all his debts of every nature and over and above his liabilities as bail, surety or otherwise; that he has offered himself as surety in good faith and with the intention to execute the bond required by the law if the contract should be awarded to the person or persons for whom he consents to become surety.

An officer of a corporation should not be accepted as surety for such corporation, nor should a firm be accepted as surety for a member of the partnership. In other words, a firm as such, should not be accepted as a surety upon a bond for any of its members, nor a partner for a copartnership of a firm of which he is a member. Stockholders who are not officers of a corporation may be accepted as sureties for such corporation.

Bidders should not be permitted to change the sureties on the bond submitted by them if they are acceptable to those letting the work.

Careful investigation should be made of the financial status of individual bondsmen offering themselves as securities on contractors' bonds, and no bonds of individuals should be accepted until it is conclusively shown to the satisfaction of those letting the work that such bonds afford ample security for the fulfillment of the undertaking in question.

CONCLUSIONS.—In conclusion, it might be stated that in the advertisement for bids, there should be a statement of the procedure that will be followed in receiving and opening bids, letting the contract and executing the same. These rules should be strictly adhered to, as they are a part of the basis on which bidders make their prices, and deviations therefrom are almost sure to work injury to someone.

Cement as an Iron Preservative.—Tests are to be made by the Isthmian Canal Commission to determine the value of cement mortar, applied to iron plates by the "cement gun," as a preservative of iron. Twelve plates, 63.8 × 14 ins., have been coated with a 1:3 mortar of cement and sand, after they were cleaned to grey metal by the sand blast process. Six of these have been covered with a ½-in. coating, and the remaining six with a 1-in. coat on one side, and a 1½-in. coat on the other. Three plates of each kind have been sent to Balboa, and three to Cristobal, where they will be kept immersed in salt water to test the mortar method of preventing corrosion. Two plates of each kind will be taken from the salt water bath at the end of three months, and one-half of the coating will be removed to determine the condition of the metal. The duration of the test for the balance of the plates will be determined later.—Canal Record.

The Underground Pneumatic Tube System for the Transportation of U. S. Mail.*

By B. C. BATCHELLER.†

Prior to the year 1892, the only extensive systems of underground pneumatic tubes were the 2¼ and 3-in. tubes in London used in connection with the telegraph for forwarding messages from sub-stations to the central office; similar small tubes in Paris, Berlin and Vienna, used by the Government for sending messages; one or two lines in New York City, used by the Western Union Telegraph Co. in connection with its telegraph systems, and a few other short, isolated tubes, none of which were more than 3 ins. in diameter. Besides these, several experimental underground railways were constructed, and operated by pneumatic propulsion, some of them large enough to carry passengers, but they never went beyond the experimental stage.

While these small tubes fulfilled their purpose admirably, there seemed to be a field for tubes of a size suitable for the transportation of letters, parcels, etc., within the limits of large cities, where traffic was becoming more congested each year. Pneumatic tubes seemed to be especially well adapted to the transportation of letters between central post offices, railway stations and the numerous branch post offices. Here were large quantities of mail, that could be made up in parcels of a size adapted to a tube of 6 or 8 ins. in diameter, being forwarded at every hour of the day and night. To transport them by tube would not only give more rapid transit, along an unobstructed route but would give a continuous service, reducing the congestion in the post offices that results from holding mail for wagons leaving at scheduled times. The tubes would give a more even distribution of work for postal clerks than obtains when the mails arrive in large bulk at irregular intervals. The removal of some of the wagons from the crowded streets was another strong argument in favor of the tubes. Thus it came about that the new system was first applied to the transportation of the mails.

A beginning was made in Philadelphia by the construction of a double line of 6-in. tubes about five-eighths of a mile long between the central post office and one of the branch stations. It was an innovation, and five years elapsed before its possibilities were sufficiently appreciated to secure the necessary appropriation for an extension, but in 1897 the enterprise went rapidly forward. During that and the succeeding year, 15 miles of 8-in. tubes were laid in the city of New York, about four miles in Philadelphia, and a shorter length in Boston. The present mileage in five cities is approximately as follows: New York, 57¼; Philadelphia, 20; Boston, 14; Chicago, 18¼; St. Louis, 4. The total mileage is 113½.

The tubes are always laid in pairs for sending in opposite directions; therefore, the length of the lines between stations is one-half that just given.

The New York system, as shown on the accompanying map (Fig. 1), consists of five lines radiating from the central post office, viz.: a line to Brooklyn, via the Brooklyn Bridge; a line to branch stations "Wall Street" and "P", the latter located in the Custom House; a line to the "Hudson Terminal"; a line extending northward on the east side of the city as far as 125th street, connecting to eight branch stations including one in the Grand Central Depot; and a line extending northward on the west side of the city, connecting to the east-side line at 125th street, and tapping ten branch stations en route. The east and west-side lines are cross-connected at the Grand Central Depot. In Brooklyn there is a line from the central post office to the Long Island Ry. Station, on Flatbush avenue. There are altogether 25 tube stations, ten of which are equipped with power plants for compressing the air, using either steam or electric power. The air compressors take the expanded air from the incoming tubes, and after compressing it, discharge it directly into the outgoing tubes, thereby maintaining constant circulation with the pressure in the tubes always above that of the atmosphere. At all the stations the tubes terminate on the ground floor in the heart of the mailing division, so that letters have to be carried only a few feet from the sorting cases to the tube, and vice versa. The mail is sent through the tubes at an average speed of 30 mi. per hr., in steel carriers which are about 7 ins. in diameter by 21 ins. long (inside measurements). They carry from 200 to 600 ordinary letters and weigh, when filled, about 30 lbs.

During the past year a double line of 8-in. tubes has been constructed for the U. S. Treasury Department, between the Custom House and the Appraisers' Warehouse in New York City. This line is about two miles in length, and is owned and operated by the Government. It is used for the transmission of letters, documents, etc.

The mail tube systems in the other cities are similar in all important respects to the New York system and, therefore, call for no further description.

*Abstract of a paper presented before the Congress of Technology at the Massachusetts Institute of Technology, April 11, 1911.

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The Flow of Air in Tubes.

The laws governing the compression of air under various conditions are stated, extensively discussed and illustrated by numerous examples in the many text books used in technical schools and by the engineering profession generally. The

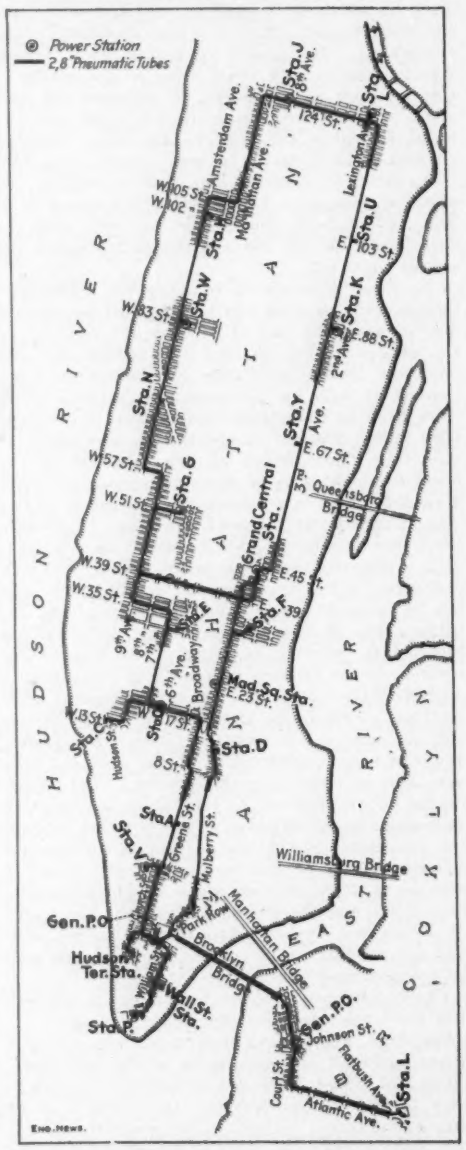


Fig. 1. Map of the Pneumatic Tube System for Transporting Mail in New York City.

text books also devote considerable space to the flow of air through orifices, but they usually treat the subject of the flow of the air in long tubes briefly and imperfectly, giving a few simple formulas which may be sufficiently accurate for ordinary purposes, for example, to ascertain the loss of pressure between an air reservoir and a rock drill, but which are almost useless in determining the loss of pressure in a pneumatic tube line, where more than 90% of the work of compression is expended in overcoming the frictional resistance to flow through the tube.

At the outset a search was made for all available formulas and experimental data bearing upon the subject. The ninth edition of the Encyclopedia Britannica contains an article by Professor William Cawthorne Unwin on the subject of hydro-mechanics, and this article includes formulas expressing the laws governing the flow of compressible fluids in pipes, with coefficients based on a number of experimen[ts] Professor Unwin has since treated the subj[ect] in a book, entitled "Development and Tra[nsmission] of Power." In its last analysis th[e subject has] to deal with extremely intricate p[henomena, and] we can never hope to express th[em completely] by mathematical symbols; but th[e formulas we] have are rational and sufficiently [accurate for] engineering purposes.

The well-known formula for th[e flow of water] through long pipes is known, f[rom] wide experience with pipes of varying [diameters and] lengths, to give the velocity of flo[w with a high] degree of precision. Professor U[nwin] reasoned that a formula of similar form, w[hich] embodied also the well-known laws of th[e expansion of] gases and which thereby takes [into] consideration the varying density of th[e fluid, should] express with equal precision the v[elocity of flow] of air or other gas, provided corr[ect values are] used for the experimental coefficie[nts]. Proceeding upon this theory, he derived a formula by equating the change in kinetic energy to the work of overcoming friction, expressed as in the case of the flow of water, and the work of expansion of the fluid. He assumes that the expansion takes place at constant temperature, and in practice it is found that that assumption is practically true. Most of the work of expansion is expended in friction of the air, which reappears in the form of heat: thus the temperature of the air remains unchanged. In flowing through long, metal tubes the air is most effectively stirred and quickly gives up its heat to, or receives heat from, the tube. The surface of the tube is very large compared with the quantity of heat transferred. Therefore, the temperature of the air in the tube and the air or earth surrounding the tube do not differ much after the air has flowed a short distance. Experiments with the underground postal tubes in Philadelphia showed that the temperature of the air in the tubes was practically the same as the temperature of the ground in which the tubes were laid. Experiments at St. Gothard's tunnel showed that the temperature of air flowing in a pipe 6,000 meters long, was at every point only about 3° C. below that of the air surrounding the pipe.

Professor Unwin pointed out that the experimental coefficient, which enters into this formula, varies somewhat with the diameter of the tube, and he has given a simple, empirical formula to express this variation, which is almost exact within the limits of our experience. This was demonstrated by the experiments of Culley and Sabine on the small telegraph tubes in London; Stockalper's experiments at St. Gothard's tunnel; Riedler & Guthermuth's experiments on the Paris air mains, and experiments of the writer on the 6-in. and 8-in. postal tubes in Philadelphia. The Philadelphia experiments seemed to indicate that the coefficient in the Unwin formula varied slightly with the velocity of the air, or with some other function which varied with the velocity; but to what extent this enters as a disturbing element, only future experiments can demonstrate.

The Unwin formulas show the limitations of pneumatic propulsion—the absolute impossibility of operating a tube more than a few miles in length at a high rate of speed. This was well worth knowing, for many people have dreamed of pneumatic tubes connecting remote cities for the purpose of transmitting messages and parcels at great speed. The formulas show that it is physically impossible to obtain a mean speed of more than 30 m. per hr. in an 8-in. tube more than 8.35 miles long, even through the initial pressure were infinite. This is an application of the formulas beyond the limits of experiment, but it serves as a warning against useless expenditure of money.

By means of the formulas it is possible to compute the air pressure and velocity at any point in a tube, the volume of air to be supplied, the power that must be expended and other information important to know before beginning the construction of a physical system.

The carriers complicate the problem somewhat by introducing additional resistance, but a satisfactory solution of this case has been found. Carrier friction is a constantly varying quantity, depending upon the weight of the carrier and the amount of lubricant in the tube. When the tube is dry the friction is about 0.4, but when there is moisture present, the friction is less than half this amount. By introducing into the formula a term to represent this carrier resistance, it is seen that the work expended in moving the carriers is small compared with the work expended in moving the air, but that the difference decreases as the velocity increases.

Objections to a Vacuum System.

Tubes can be operated either by compressed or rarefied air, but the former has been exclusively used in the underground systems that are the subject of this paper. If the air is exhausted instead of compressed, closed receivers must be used at all stations. This type of receiver is more expensive to manufacture and maintain than open receivers, and being more intricate, gives more trouble in operation. Furthermore, some supplementary force must be provided to remove the carriers from the receiver, since the atmospheric pressure is higher than the pressure in the tube. In small tubes gravity can be used to do this, but with 8-in. tubes there is usually insufficient room in the stations to allow the terminals to be so placed that the carriers will slide out of the receiver under the force of gravity. Long lines of underground tubes will eventually leak more or less, and through these leaks, dirt, sand, water, etc., would be drawn in if the pressure inside were less than the atmospheric pressure outside. This, however, is not the case if the pressure in the tube is above that of the atmosphere, which is a strong argument in favor of compressed air.

The method of operating by exhausting the air is more economical, so far as the expenditure of power is concerned, and the dispatching mechanism at the initial end of the tube is simpler; but the working pressure is limited to something less than 14 lbs. per sq. in., and there might be conditions making that insufficient.

The relative theoretical horse-powers required to operate 8-in. tubes of varying lengths to give a mean air velocity of 30 mi. per hr., by compression and exhaustion, are shown in the accompanying diagram (Fig. 2). Since none of the air circuits in any of the existing tubes exceeds 20,000 ft. in length, and most of them are less than 15,000 ft., the advantage of the latter method is not so great as at first appears.

Materials and Manufacture of the Tubes.

The material for the tubes and the process of their manufacture were subjects that called for serious consideration. Brass, lead, wrought iron and steel had been used for small tubes, but the precedents were of little importance. The first attempt was to obtain 6-in. lapwelded iron or steel tubes, expanded and made smooth on the interior by drawing a mandrel through them. They were smooth enough, but varied so much in diameter at the ends of the lengths, where they must join, that they were rejected. This was probably fortunate, for had they been otherwise satisfactory, their rigidity, unless made very thick, would have been insufficient under the severe strains to which they are sometimes subjected when laid underground.

The next material selected was cast-iron. This has stood the test of time and has become the standard for all large tube construction. The first tube line was made of lengths of bored cast-iron water pipe, machined at the ends to fit one into the other, and so insure smooth joints on the interior. The pipe was a little too thin resulting in an occasional break, but otherwise it was entirely satisfactory and is in use to-day. Since this first experiment, the pipe has been cast of proper thickness and of a good mixture to give sound castings that can be readily bored. A bell-and-spigot joint calked with yarn and lead, so common in gas and water pipes, has been the standard joint for pneumatic tubes from the beginning, excepting special lengths, which have flanged and bolted joints.

BORING MACHINES.—To bore accurately and economically large quantities of tubing necessitated specially designed boring machines and elaborately equipped plants, several of which have been constructed. The first permanent plant was equipped with vertical boring machines—made vertical in order to keep the cutters clear of chips by gravity—provided with special adjustments for quickly bringing the axis of the tube to coincide with the axis of the boring tool. The tube was held stationary while the boring bar and cutters revolved and fed downward into the tube. An overhead track and trolleys were designed to transport the tubes to and from the boring machines, and small cranes at each machine facilitated the transfer of tubes from the trolley to the boring position.

Two other plants were equipped with horizontal boring machines, in which the tube was made to revolve while a non-revolving cutter head on the end of a square boring bar was slowly fed through the tube. These machines required fans to keep the cutters clear of chips. The horizontal machines had one advantage over the vertical, in that they had means for finishing the ends of the tubes by the use of special cutters attached to the boring bar. In the first plant equipped with vertical machines, the ends of the tubes were finished in separate machines designed for the purpose, which necessitated two settings of each length of tube.

It was found possible to bore about 6 ft. of 8-in. tube per hour, and the tube was finished at one passage of the boring cutters.

CURVED TUBING.—All that has thus far been said regarding tubes and their manufacture refers to straight tubing. In order to make short bends in a tube line, it is necessary to have specially bent or curved lengths. At first these were made of seamless brass, drawn and bent to the desired radius. To bend them they were first filled with rosin, then passed back and forth through rolls until the desired curvature was obtained. The next process was to remove the rosin, a slow and tedious process at best; then a series of mandrels were driven through the bent tubes one after the other, each mandrel being slightly larger than its predecessor; the purpose of the mandrel being to give the tube a uniform, circular cross-section of correct diameter. The last process was to cut off the ends of the bent tube and attach flanges by soldering.

These brass bends were expensive and difficult to manufacture. When laid in the ground they required a covering of concrete or brick-

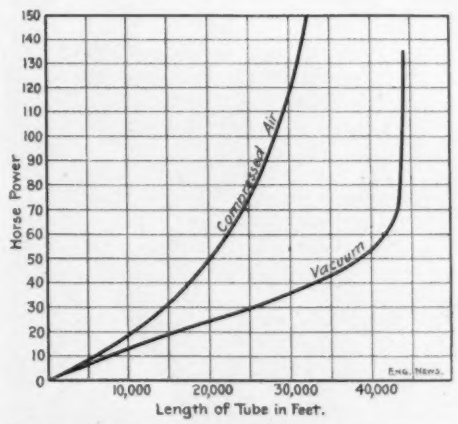


Fig. 2. Curves Showing Relative Power Requirements of the Compressed Air and Vacuum Systems for Pneumatic Tubes.
(Operation at mean speed of 30 mi. per hr.; 8-in. tubes.)

work to protect them from external injury, and on account of the softness of the material, the carriers wore holes through them in three or four years.

When the brass bends began to wear out, it was evident that some other material must be found. A few steel bends were used in New York, but they did not wear much, if any, longer than the brass. Much study was given to the subject, which resulted in devising a process of casting iron bends with an inner surface so smooth and accurate to dimensions that they only required a little grinding with an emery wheel to finish the interior. The only machine work on them consists of counter-boring the ends, and facing and drilling the flanges. These curved sections of tube are made 22½°, 11¼°, 7° 10 and 5° in length of arc, and by combining them a bend of almost any desired angle can be secured. They are much less expensive to manufacture than the brass bends; they are more accurate in curvature, and they are as durable as the straight cast-iron tubing. The production of these curved cast-iron tubes is one of the important achievements in the development of the system.

Air Compressors.

To operate the first line of tubes in Philadelphia a duplex steam-driven air compressor was selected. It was thought that a duplex compressor, which gives four discharges per revolution, was necessary to secure a uniform flow of air in the tube, and this opinion was borne out by experience. This machine and every subsequent machine that has been installed runs at constant speed, delivering a constant volume of air per minute which maintains a nearly constant average carrier speed in the tube. When no carriers are in transit, the air pressure is determined by the length and diameter of the tube, since it is due entirely to friction of the air flowing through the tube. Speaking roughly, about 3 lbs. pressure per sq. in. per mile of tube is necessary to give a mean velocity of 30 mi. per hr. in an 8-in. tube; but the initial pressure per mile of tube increases as the length of the tube increases, so three pounds is only correct for the first one or two miles.

When carriers are in transit, the initial pressure fluctuates, depending upon the number of carriers in the tube, the weight of the carriers and the amount of moisture present, which acts as a lubricant. By maintaining a constant compressor speed, the quantity of air flowing through the tube is constant and the pressure automatically adjusts itself to the load. None of the mail tubes requires an initial pressure much in excess of twelve pounds, and many of them not more than six or eight pounds. The compressors are, therefore, low-pressure machines.

At all the power stations, excepting those located in the central post-offices and at Madison Square branch in New York, electric motors are used to drive the air compressors. Two types of compressor are used; one having two double-acting air cylinders with reciprocating pistons, driven by cranks on the ends of a common crank-shaft; the other, a rotary machine of the type commonly known as a Root blower, consisting of a pair of two-toothed gears, called impellers, revolving together within a close-fitting iron case.

The reciprocating piston compressors all have mechanically-moved Corliss intake valves in the heads of the cylinders, which receive their motion from eccentrics on the crank shaft. Both poppet and Corliss outlet valves have been used, but the latter are more satisfactory. The usual objection to mechanically moved outlet valves, that their point of opening in the stroke does not change to suit varying pressures, is not an important objection in this case, for the reason that the pressure varies within such narrow limits. With such low pressures, the mechanically moved valve opens more promptly and is much quieter than a poppet valve. In some of the earlier machines, power is transmitted from the motor to the compressor by leather belts, but all machines installed during the past four years have had the armature of the motor mounted on the compressor shaft. The cranks and crossheads are enclosed in the frame and are lubricated by the splash system, or by forced circulation. The eccentrics are also enclosed and dip into a reservoir of oil at each revolution. The air cylinder and valves are provided with sight-feed lubricators.

The rotary compressors have given most satisfactory results up to about 8 lbs. air pressure, and a large number of them are used in the New York system. One of these, installed at station "J," 2309 Eighth Ave., is shown in Fig. 3. Their efficiency is equal to that of the piston compressors at 6 lbs. pressure and exceeds it at lower pressures. Their first cost is only one-half that of the piston compressors, and they require far less attention in operation. They have the further advantage of occupying much less floor space. When electric-driven, the motor is mounted on the bedplate and directly connected to the compressor shaft. There are five bearings, all provided with oil reservoirs and oiling rings which give automatic lubrication. These rotary compressors differ from the ordinary Root blowers used for blowing cupola furnaces, only in having the impellers much shorter, relative to their diameter; in more accurate workmanship, which makes it possible to have less clearance between the impellers and the casing; and in greater weight and strength.

The discharge from the rotary compressors is more pulsating than from a duplex piston compressor, necessitating the use of a small tank with each machine to reduce the pulsations before the air enters the tube.

Both types of compressor have been developed by the requirements of the pneumatic-tube service, and both will probably continue to be used. It is the custom to install at least one piston compressor in each power station, provided with an extra-powerful motor, in order to obtain a pressure of 25 to 30 lbs. if required to remove blocks in the tube lines.

Terminal Machinery.

The records of the Patent Office show that the terminal machinery has been the subject of most pneumatic-tube inventions. As small tube terminal systems were not generally applicable to large tubes, this field had scarcely been touched when the development of the underground system began.

There are two distinct machines on every tube line. One is used in dispatching to insert the carrier into the tube without allowing the com-

pressed air to escape and is called the transmitter; the other is used to stop the carrier when it arrives at a station and automatically discharge it from the tube. It is called a receiver. There are two types of receiver, the open receiver for use at the open end of the tube, and the closed receiver which is used at intermediate stations where the pressure in the tube is considerably higher than atmospheric. At these intermediate stations an air-lock is necessary to prevent a violent escape of air when the carrier is discharged. In addition there is a modified form of closed receiver that automatically selects and discharges from the tube the carriers intended for its station, allowing other carriers to pass on in the tube to a succeeding station.

TRANSMITTERS.—Several types of transmitter have been devised. The earliest and simplest form consists of a cylindrical chamber, just large enough to receive a carrier, mounted on trunnions and enclosed in a circular box which has three openings—one through which the carrier is inserted, another through which the air enters, and a third through which the air and the carrier pass out into the tube. The receiving chamber is rotated on its trunnions by a hand lever from the position opposite the opening through which the carrier is inserted to the position in line with the line tube opening. The carrier is then driven forward by the air current. In the latter position the opening through which the carrier is inserted is closed by a circular plate that prevents the escape of air. The device is nothing more than a large two-way cock. It was never extensively used because of the labor of turning it by hand, as originally designed.

The next type of transmitter consisted of two sections of tube a little longer than a carrier, so mounted in a swinging frame that either section could be swung into line with the tube, their motion being transverse to the axis of the tube. In dispatching, the carrier is placed in one of the tube sections and swung into line with the tube to be driven forward by the air current; then the tube section returns to its original position to receive the next carrier. When one of the tube sections is swung to one side, the other is in line with and maintains the continuity of the tube. The two movable tube sections and their supporting frame are swung forward and back by an air-operated cylinder and piston having a slide valve controlled by a hand lever. An automatic device provides for the return of the tube sections to their first position immediately after a carrier is dispatched. This type of transmitter was extensively used but finally gave way to a more compact and less expensive type known as the gravity transmitter.

The gravity transmitter is an air-lock with two counter-weighted swinging doors that are opened successively by the weight of the entering carrier. The chamber between the doors is of the same diameter as the tube, and just long enough to receive one carrier. It is a prolongation of the line tube inclined at an angle of 45°. The air current enters the tube through a lantern casting just below the lower door. A carrier is dispatched by placing it on the upper door, which immediately swings downward and to one side, allowing the carrier to enter the chamber between the doors. The first door then closes, due to its counter-weight, and in so doing moves a valve that admits compressed air from the tube to the chamber, thus establishing an equal pressure on the upper and lower sides of the second door; then the weight of the carrier opens the second door and the carrier slides down into the tube, to be driven forward by the air current. When the second door closes after the carrier has passed, it moves the valve that admitted compressed air to the chamber back to its original position, thereby emptying the chamber in readiness to receive the next carrier.

The gravity transmitter has become the standard type used in all the cities where tubes have been laid. Two of these transmitters are shown in Fig. 4. They have been made in several forms, differing only in details of construction.

All transmitters are provided with a timing device to limit the frequency with which carriers can be dispatched. This is necessary to insure a sufficient time for the receiver to discharge one carrier before the next arrives. The timing device locks the transmitter as each carrier is dispatched and keeps it locked for a predetermined time, usually between 10 and 15 seconds. Two forms of timing device are used, one measuring time by the displacement of oil, the other by the displacement of air. The essential principle of both forms is a loaded piston moving up and down in a cylinder as each carrier passes through the transmitter. This piston forces a definite quantity of oil or air through an orifice that can be adjusted in size to give the required time interval. Clocks with an electrical attachment have also been used for timing devices with the advantage of greater uniformity in time interval but with the disadvantage of more delicate mechanism.

RECEIVERS.—Open receivers have been made of two radically different types. One arrests the carrier by means of an air-cushion, the other by friction of a curved chute and a [illegible]lastic buffer at the end. In the former, the end of the tube is normally closed by a sliding or [illegible]olving gate. The air current leaves the tube [illegible]ough a lantern casting, located about twice [illegible] length of a carrier from the gate, and flows t[illegible]gh a branch pipe to the atmosphere. The spa[illegible] between the lantern casting and the gate forms a dead-end into which the carrier runs, compressing the air in front of it and bringing it to rest without shock. The compresison of the [illegible] in the dead end moves a valve that causes t[illegible] gate to open, allowing the carrier to pass out on to a receiving table, and the gate automatically closes behind it.

In the second type of open receiver the end of the tube is always open, terminating in a semi-circular table having a chute along the outer circumference. The by-pass through which the air current leaves the tube is located beneath the floor on which the receiver stands, about 12 or 15 feet from the open end, and the tube from the by-pass up to the receiving table is formed in a reverse curve. The carrier, after passing the by-pass, being no longer propelled by the air current, is gradually brought to rest by the friction of the curved tube and the circular chute of the table. The air current is deflected through the by-pass by having the latter connected to the suction side of an air compressor that is supplying compressed air to another tube leading out of the station.

The closed receiver is necessarily a more elaborate piece of mechanism. The earliest type has a receiving chamber which forms a prolongation of the tube with its outer end closed. The air current leaves the tube through a lantern casting located close to the receiving chamber, so that the latter forms a dead end, into which the carrier runs and cushions against the air compressed in front of it, as in the first type of open receiver. The receiving chamber is mounted on trunnions and arranged to be tipped up to allow the carrier to slide out backward. When the chamber is in an inclined position allowing the carrier to slide out, the end of the tube is covered by a curved plate attached to the chamber. The receiving chamber is moved from the horizontal to the inclined position and reverse by an air-controlled piston and cylinder set into operation by the arriving carrier. Thus the entire movement is automatic.

The latest type of closed receiver consists of a receiving chamber between two gates, the first normally open and the second closed. The receiving chamber is a prolongation of the tube forming an air cushion to stop the carriers, as in the first type. The air current leaves the tube through a by-pass located close to the first gate. When a carrier arrives in the receiving chamber, it moves a valve that admits air pressure to a cylinder and piston which closes the first gate and then opens the second. When the second gate is wide open, another valve is moved that admits sufficient compressed air into the receiving chamber behind the carrier to push the latter out on to a table; then the second gate closes, the first gate opens and the apparatus is ready to receive the next carrier. The air pressure available to operate the closed receiver is sometimes less than 2 lbs. per sq. in., which necessitates making the operating cylinder of large diameter.

Several forms of the double-gate closed receiver have been used. One is made with sliding gates and two others with revolving gates, each with different mechanism to operate the gates. The revolving gate type is shown in Fig. 4 and the sliding gate in Fig. 5. The aim of all designers has been to make a closed receiver that is certain in the delivery of arriving carriers; quick in its movements, to insure the delivery of each carrier before the next arrives; quiet in its operation; and mechanically strong to withstand the severe shocks to which it is sometimes subjected.

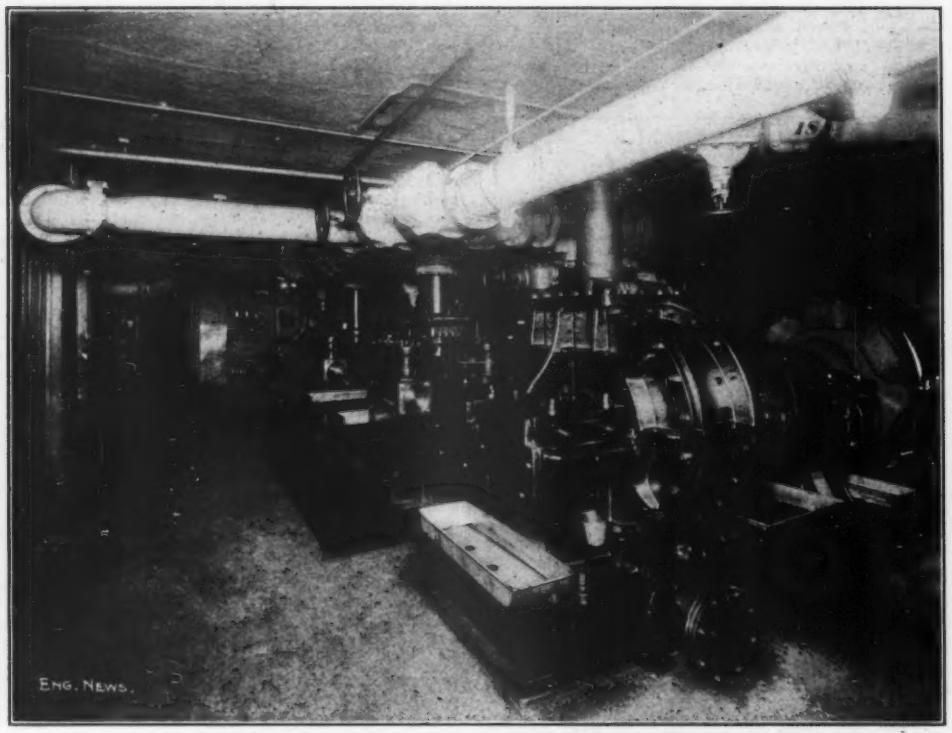


FIG. 3. ROOT BLOWER IN ONE OF THE COMPRESSOR STATIONS OF THE NEW YORK PNEUMATIC TUBE SYSTEM.
(Two reciprocating compressors and a second rotary blower are partially visible in the background.)

Automatic Switching.

There is one great problem that arises in the mind of almost every person who gives the subject of pneumatic tube transmission any thought. It is the problem of automatic switching. Broadly, it may be defined as the problem of sending a carrier automatically from any station on a network of tubes to any other station; or in a more restricted sense, it is the problem of automatically sending a carrier from a main tube into a branch, and vice versa. It is a fascinating problem, like that of the rotary steam engine, and many have tried their hand at it. At first thought it gives the impression that its solution is within reach, although the means of attaining it are not quite apparent.

The problem has been solved to some extent in several ways, of which there are practical working examples, but as broadly defined its solution is impossible. Some of the conditions that make it impossible may be cited. The air current in a tube cannot be divided between two tubes and maintain the same velocity in each. A branch tube must therefore be operated as a separate air circuit, and since the pressure of the air is usually different in the branch and main line at the point of junction, the carrier must pass through some form of lock or gate in going from one to the other. Automatic gates or locks are hardly practicable, especially when placed under ground. Inside buildings the space for tubes and machinery is usually limited, making many devices which are theoretically possible, practically impossible. A carrier, in order to select its own route must be provided with some route-selecting form or device, such as a recess or projection of a given size at the front end, and there must be as many combinations as there are different routes, but a practical limit to the possible number is soon reached. Carriers must be dispatched under short headway to give the tube large carrying capacity, and all automatic devices are subject to the complications which arise when two or more carriers arrive together instead of separately. When a carrier enters a main line from a branch, there is the risk of a collision with a carrier running in the main line. If it is necessary to stop a carrier in transit, it must be done gradually to avoid destructive shocks. These are a few of the many requirements and limitations that must be recognized in attempting to solve the problem.

Automatic switching, however, is in use to some extent in small tube systems for carrying cash, messages, etc., usually limited to the interior of buildings; and even in large tube systems where several stations are placed on a line with a pumping station at the initial end, automatic selective receivers have been used at the intermediate stations to arrest and discharge from the tube the carriers intended for the respective stations, allowing all others to pass on in the tube. Each carrier has attached to it a device that determines the station on the line at which it will stop, and with two tubes operating in opposite directions, it is thus possible to send a carrier from any station to any other station without manually redispatching it at the intervening stations. Such systems are limited to about half a dozen stations on an air circuit and are now but little used.

A tube station in Philadelphia, at the Reading Railway Depot, on a line between the central post-office and the Pennsylvania Depot, was equipped with these automatic selective receivers, which were in operation for about ten years, and were only displaced when a separate tube line was laid from the central post-office to the Reading Depot. At present there is only one of these selective receivers in use in New York, and that is at "Wall Street" station. The others were gradually displaced by changes in the tube line and the removal of stations. There will probably be no more of them installed for several reasons: Their first cost is high; a more intelligent and consequently more expensive class of labor is required to operate them; the time and inconvenience of attaching and removing selective disks from the carriers is considerable, and there are disadvantages in reserving certain carriers for particular stations. These disadvantages seem to more than offset the saving in labor of redispatching carriers by hand at the intermediate stations.

Carriers.

No other part of the system has been the subject of more thought and study than the carrier, which is the vehicle in which the letters or parcels are placed for transportation through the tube. In general form there has been but little change since the first carrier was designed, but the details have undergone modifications in a process of evolution leading up to the carrier now generally adopted as a standard type.

Briefly described, the carrier for an 8-in. tube has a cylindrical body of sheet steel, 7 ins. in diameter and 23 ins. long. The forward end is closed by a stamped steel cap secured to the body by soldering. Attached to this cap on the outside is a circular buffer of felt, which absorbs the energy of impact when the carrier runs against another object. The carrier is filled and emptied through the rear end, which is provided with a tightly-fitting, circular, dished lid of the full diameter of the body. The lid is attached to the body by a three-leaf hinge and carries a simple locking device. The cylindrical body is surrounded by two bearing rings, placed at such distance from the ends as will allow the carrier to pass through bends in the tube. The bearing rings, on which the carrier runs, are made of cotton duck and rubber highly compressed and vulcanized. They are held in place by steel rings, which are soldered to the body. The body, front cap, lid and most of the metal parts are coated with tin, to facilitate soldering and to prevent oxidation. Each carrier weighs about 20 lbs. Their general appearance is shown in Fig. 5.

The requirements of a satisfactory carrier are numerous and exacting. It must be strong to withstand the rough usage that it constantly receives; it must be light because the power to propel it, the labor of handling it and the energy stored in it all increase directly with its weight; when closed it must be water-tight to protect the contents from injury; there must be no rivets, nuts or other small parts that can become detached to remain in the tube and obstruct a following carrier; the lock that secures the lid in the closed position must be so secure that the carrier cannot open in transit and spill its contents; the locking mechanism must be so designed that the carrier cannot be put into the tube when it is unlocked; the manipulation of the locking mechanism must be simple, to facilitate handling; the opening through which the carrier is filled and emptied must be large and unobstructed, otherwise there is loss in time and labor; and the bearing rings must have a low coefficient of friction, great wearing qualities, be noiseless in the tube and be unaffected by water, oil or a moderately high temperature.

In an endeavor to meet these requirements, many carriers have been designed and tested during the past 18 years. To have a carrier open during transit and lose its contents in the tube is of all accidents most serious; therefore, most thought has been given to the design of mechanism for securing the lid in its closed position. The present lock is simple—altogether the best that has been devised. It is manipulated by a lever which turns on a pivot located eccentrically on the lid. Due to this eccentricity, the lever in the unlocked position projects beyond the circumference of the lid and thus prevents the carrier from being inserted into the tube. The lever cannot be swung to the locked position across the lid unless the carrier is closed, which prevents locking the carrier open. The lid is secured to the body on one side by a lug that projects into a slot milled on the inside of the body, and on the other side by a cam, moved by the locking lever, that engages a projection on the leaf of the hinge riveted to the body. Thus the lid is secured at two opposite points. There is a further safety device in a spring catch, which locks the cam and lever in the locked position. This catch can be released by pressing a button on the lid.

The quality of steel used in the carrier bodies has been the subject of considerable experiment. The advantages of a high carbon steel were recognized from the beginning, and recently some of the new special steels have been tested. All purchases are now made to specifications, the quality being determined by chemical analysis. Through all this development, cost has been an important factor, and often a limiting one, but to-day the carriers are made for less than one-half what they cost ten years ago, and their life has been more than doubled.

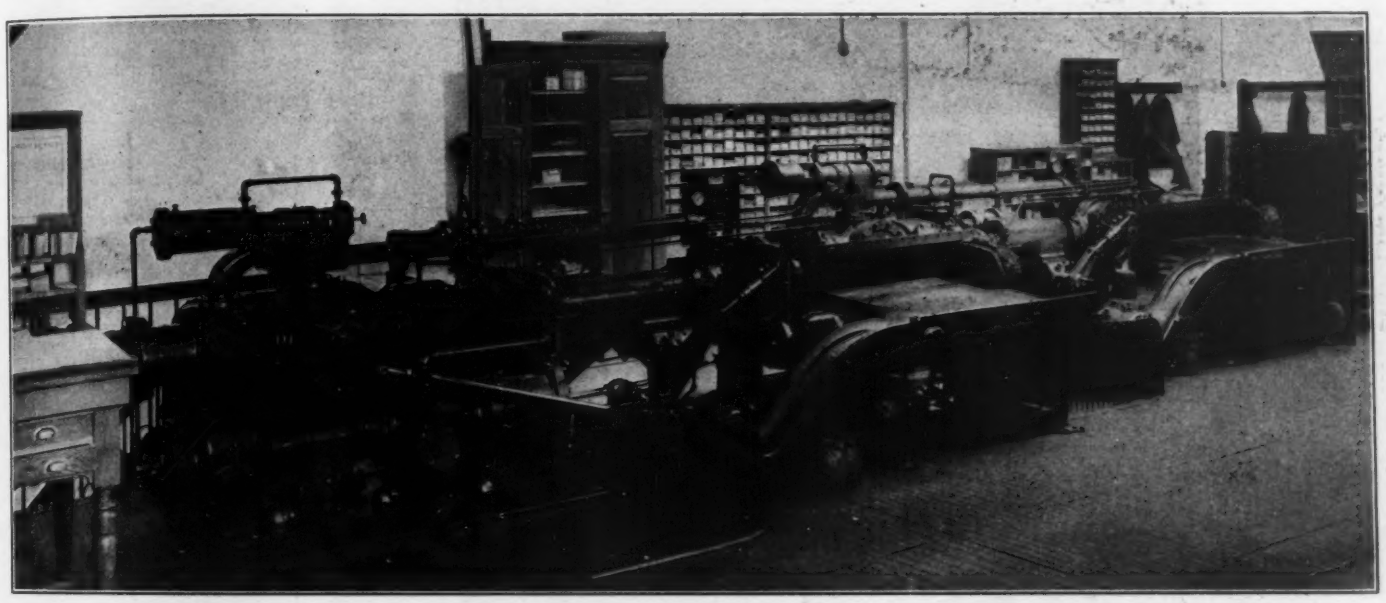


FIG. 4. CLOSED RECEIVERS AND GRAVITY TRANSMITTERS OF THE NEW YORK PNEUMATIC TUBE SYSTEM.

(View in station "A" at Greene and Prince Sts. The receivers deliver the cylindrical carriers against the buffers of cotton waste at the backs of the metal tray tables. The curved troughs from the front corners of the tables lead to the transmitters.)

Tube Line Construction.

The difficulties of laying pipes in city streets are increased in the case of pneumatic tubes, by the necessity of laying them nearer to a straight line than other pipes, all changes in direction being limited to slight deflections at the joints, and to standard bends of 8-ft. radius. In only one city—Philadelphia—has any effort been made to keep complete municipal records of all underground construction; therefore, in all other cities in selecting a location for a projected line of tubes, information concerning space available beneath the surface must be obtained by an examination of the street and from companies that have underground conduits in those streets. It is customary to gather all possible information from these sources and compile it by making

sectional elevations at frequent intervals along the route, and plans of important street intersections. The greatest difficulties are usually met at intersections of the streets, for there the conduits of two streets are interlaced and a large amount of space is occupied by vaults that give access to the electrical conduits. During the past 30 years many conduits for electric wires have been put down, until now they occupy more space than the gas and water pipes. In order to draw the cables into these conduits, it has been necessary to construct manholes at every street corner, and many of them are of large dimensions. Beside these there are sewer manholes and vaults for water gates.

The preliminary information that can be gathered from all sources is usually sufficient to determine the practicability of the route selected, and which side of the street offers the most space, but the exact location in the street can only be determined by digging test holes, usually one or two in each block. After all this has been done and the work is under way, it not infrequently happens that the location has to be changed. A trench is always opened across the intersecting streets, several hundred feet in advance of the point at which the tubes are being laid, for the depth at which they can be laid in the crossing determines their depth in the adjoining blocks.

Not all of the tubes are laid beneath the ground. A double line extends from the central post-office in New York City to the central post-office in the borough of Brooklyn, across the "Brooklyn Bridge." The tubes on the bridge are supported in saddles, which rest on the cross beams. The bridge structure is very flexible and is deflected several inches by the passage of elevated trains and trolley cars, and since there is a continuous procession of them, it is in constant motion. As a result of the movements of the bridge, considerable difficulty has been found in keeping the joints of the tubes tight. They are calked with lead, which gradually works loose, necessitating frequent recalking. Ten years after the line was put down, it became necessary to relay the entire part on the bridge. Usually it is thought necessary to lay the tubes with a cover of two or three feet of earth to prevent the moisture that condenses in them from freezing, but here are two tubes nearly a mile in length, suspended high up in the air, exposed to the elements without covering, and only once or twice in cold winter weather has there been any trouble from ice forming inside them, and then the trouble was of short duration.

Operation.

In the development of the pneumatic tube system, besides the problems of design and construction, there have been many problems of organization and operation. These latter problems have presented themselves, one after the other, as the systems have been extended. Details that are of relatively small importance in the smaller systems of Chicago and Boston require special consideration in the larger system of New York.

The systems are owned by local companies which have entered into contracts with the U. S. Government to transport the mails for a period of ten years. According to the terms of these contracts, the companies agree to transport by tube between stations connected all mail placed in the carriers during the hours of operation, which, if the Government requires it, must be 20 hours per day. Each company, therefore, has its own staff and corps of operators to dispatch and receive the carriers, to run the power machinery, repair the carriers, and maintain the system. Over this organization the post-office has no control. On the other hand, the tube operators are not allowed to handle the mail, which is tied up in small packages, according to its destination, and placed by the postal clerks in the carriers. When a carrier is filled, the tube operator locks it and dispatches it in the tube. When it arrives at its destination, the tube operator there empties the contents onto a table.

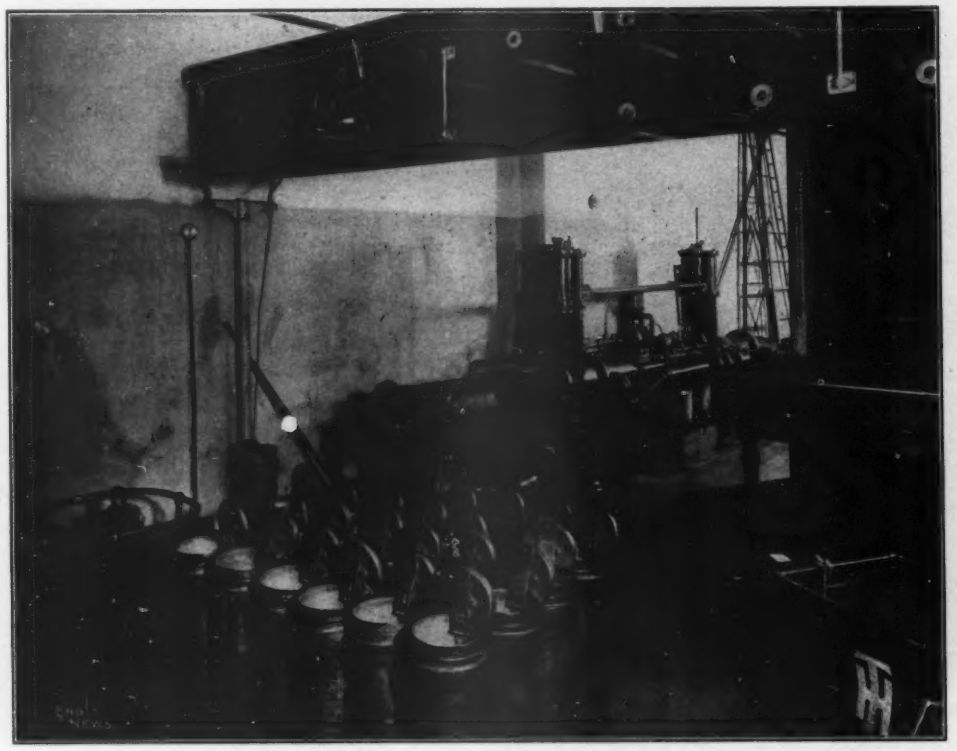


FIG. 5. A GROUP OF CARRIERS READY TO BE FILLED WITH LETTERS AT THE HUDSON TERMINAL STATION, NEW YORK CITY: SLIDING-GATE CLOSED RECEIVER IN BACKGROUND.

In the 25 stations of the New York system, 94 operators are employed at the terminals, and the total number of men on the pay roll, including chief operators, inspectors, compressor attendants and repair men is 115. The men work in two shifts, one from 4 a. m. to 1.30 p. m. and the second from 1.30 to 11.30 p. m. On Sundays the working hours are somewhat less. Three of the ten power stations are equipped with steam-driven air compressors, which require the constant attention of an attendant in the compressor room. The other power stations are equipped with electric motor driven compressors which require much less attention. They are started and stopped by the tube operator and receive the attention of an inspector at least once a day.

Each station is connected to a central telephone switchboard, located at Station "G," on 51st St. near Broadway. The switchboard operator is the chief operator of the entire system, from whom all the other operators at the stations receive their orders. Before the service begins at 4 o'clock in the morning, it is the first duty of every operator to report by telephone to the chief. In case an operator does not report, the chief knows that he is not at his post, and orders a substitute to take his place. Before receiving orders to shut down at night, each operator is required to report by telephone to the chief the receipt and dispatch of his last carriers. In this way the chief knows when the last dispatch of mail has reached its destination, and he can then order the system shut down with reasonable certainty that no carriers are left in the tubes.

In case of trouble at any station the fact is at once reported by telephone to the chief. If it is some slight irregularity in the operation of the terminal apparatus, the chief, by questioning the operator, may be able to tell him how to correct it; or, if the case demands, assistance, an inspector can be instantly ordered to the station. Should it prove to be a serious block, then the necessary orders such as "stop sending," "shut down," "reverse pressure," "increase pressure," "put on vacuum," "remove a bend," etc., are quickly given by telephone, making it possible to clear a blocked line in five or ten minutes that without the telephone could not be cleared in several hours. Frequently, when a line is blocked, orders are issued by telephone to dispatch mail by another tube route, thereby avoiding delays to the mail that would otherwise occur. Ordinarily the dispatch of mails is not subject to the orders of the chief operator. It is his duty only to keep the system running, to keep a sufficient number of operators at their posts, and to maintain a proper distribution of carriers, all of which he does by telephone.

The distribution of carriers is a most important duty of the chief operator. About 1,300 carriers are used in New York. The amount of mail dispatched and received at some stations is much more than at others, and the times of sending and receiving are irregular. If no effort were made to keep the carriers distributed, there would soon be an accumulation at some stations and a scarcity at others. This trouble would be augmented by the propensity of operators to hold carriers against their needs for heavy dispatches. The chief at the switchboard keeps constantly informed by inquiry of the number of carriers at the different stations, and where there is a scarcity he has it supplied by ordering empty carriers sent from stations that are over-stocked; but empty carriers occupy space in the tube and reduce its mail carrying capacity; therefore, the aim of the chief operator must be to so distribute the carriers that the least possible number of empties will be sent through the tubes during busy hours. This is accomplished by storing carriers at stations where they will be required for heavy dispatches, and having empties sent only during hours when little mail is being transported.

Tube capacity is the quantity of letters that can be transported per unit of time, and tube efficiency may be defined as the percentage of total capacity that is utilized. High efficiency is as important in pneumatic tube management as in other business enterprises.

The majority of business letters are dictated in the morning, written during the day, signed in the latter part of the afternoon, posted when the office closes, and collected from the boxes between five and six-thirty. Thus the bulk of the outgoing mail is handled by the post-office in the afternoon and evening. On the other hand, the bulk of the incoming mail arrives in the morning. A large number of trains from remote cities arrive about daybreak, bringing heavy mails, and there is an accumulation of local mail over night to go out in the first dispatch in the morning. These are fixed conditions that cannot be changed and that the tubes should have capacity to meet. Thus the tubes will be used far below their capacity during other hours of the day, and the total efficiency will be low.

Take as an example one of the busy lines in New York—the tube that extends from the central post-office to the Grand Central station. (Fig. 6 shows a corner of the pneumatic tube station at the Grand Central Depot. Belt conveyors are used to transfer the mail between the tubes and the sorting tables.) A record has been kept of the number of carriers dispatched every 30 minutes during the day. There was a heavy dispatch between 4 and 5 o'clock in the morning; from 5 to 5.30, the fewest carriers were sent of any half hour period during the day; between 6 and 7 the number dispatched was unusually large, but almost entirely empty carriers; from 7 to 10.30 the number was comparatively small; from 9.30 to 2 p. m. it increased

gradually, remaining large until 9 p. m from which time the tendency was downward. This refers only to the northbound tube. Most of the mail sent through it originates in the lower part of Manhattan Island, which explains why the quantity is so large in the afternoon and so small in the morning. The great bulk of morning mail is moving in the opposite direction. The average number of carriers dispatched per half hour throughout the operating period of the day was 72% of the number dispatched during the busiest half hour, from 5.30 to 6 p. m.

Tube capacity is affected by the distribution of carriers, the total number used on the system, and by the density of loading. If it is necessary to send empty carriers through a busy line, to supply some station, those carriers cut down the efficiency of that line. Had the needs of that station been anticipated in a preceding dull period, good management would have increased the efficiency of the system and that line in particular. A shortage of carriers on the entire system necessitates the more frequent dispatching of empty carriers, and, therefore, reduces the efficiency. The number of letters placed in the carriers, or density of loading, directly affects the efficiency of the system, and as it takes

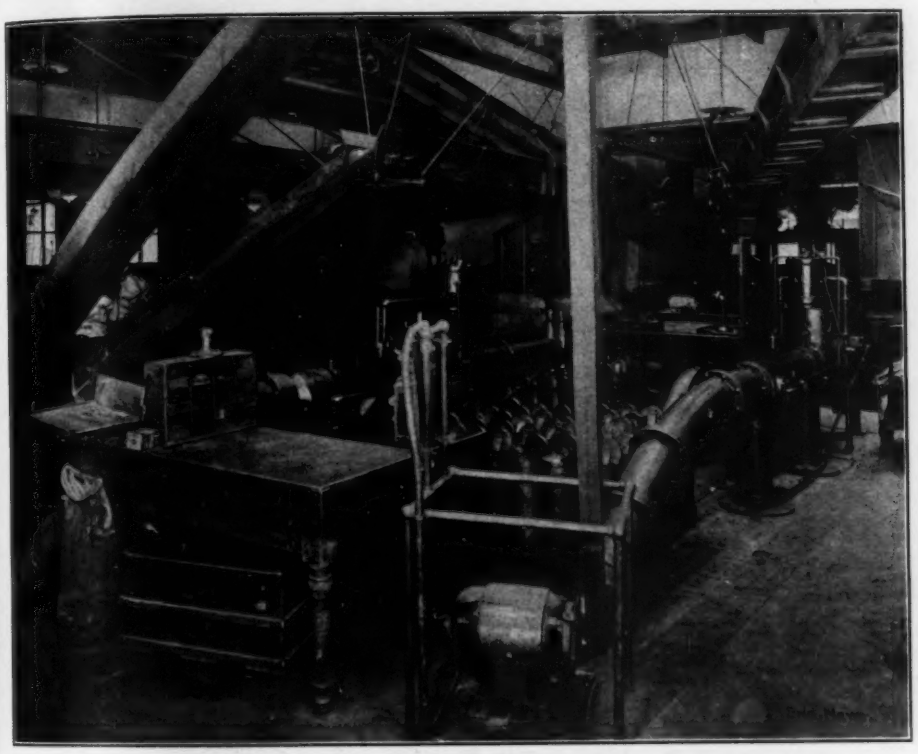


FIG. 6. TUBE STATION AT GRAND CENTRAL DEPOT, NEW YORK CITY.

more time and labor to pack carriers tightly, there is a tendency on the part of the postal clerks to fill them loosely. On the other hand, there are times when the quantity of mail to be sent is insufficient to fill the carriers and the mail cannot be delayed to secure a load. As a result, it is found that the density of loading varies during the hours of the day somewhat in proportion to the quantity of mail handled, being greatest in the afternoon and evening, and least in the forenoon.

A record was kept of the number of letters placed in each carrier during the day on which the record of carriers was kept and it was found that the density of loading varies throughout the day approximately as the number of carriers dispatched. When there is a large quantity of mail to be sent, more letters are put into each carrier. Between 6 and 7 a. m. a large number of carriers was dispatched containing very few letters, but most of these were empty carriers which had probably brought to the central post-office the heavy morning mail during the two preceding hours. The average number of letters per carrier throughout the operating period of the day was 49% of the maximum, which occurred from 4 to 4.30 a. m.

The number of letters dispatched during each half hour of the same day was large during the first half hour, then the quantity fell to a minimum at 6 a. m., increasing gradually until 6 p. m. and fell off rapidly after 9 p. m. The average number of letters per half-hour throughout the operating period of the day was 45% of the maximum number of letters sent in any half hour. The period of maximum traffic was the half hour from 8.30 to 9 p. m.

Tube capacity is affected by the geographical location of the stations and the manner in which they are connected by tube lines. When a number of intermediate stations are connected to a line through which there is heavy traffic between the terminal stations, the frequency of dispatch is less than it would be on a trunk line between the terminal stations. This, of course, does not hold true where the bulk of the mail is taken up and distributed at the intermediate stations. If, instead of connecting sub-stations to trunk lines, they are connected by independent lines to more important central stations, and the central stations are connected by trunk lines without intermediate stations (in other words, if stations are connected by a radial system) greater tube capacity is secured. The geographical configuration of New York City, the concentration of business in the southern end of the Island, and the location of the principal railway stations in the center, are conditions that have produced long tube circuits with numerous intermediate stations, instead of a radiating system such as developed in Philadelphia and Boston on a smaller scale.

The interval of dispatch, or time-lock interval, having a direct effect upon the tube capacity, becomes an important detail in tube management. It is determined by many conditions. On a short line equipped with semi-circular open receivers, such as are used in some of the Philadelphia stations, and with no intermediate station, carriers can be sent at six seconds, or about as fast as they can be handled. Where gate receivers are used, the interval should be longer, say eight or ten seconds, to insure against one carrier overtaking another in the tube. If a line is very long, the time of transit is correspondingly long, and the time-lock interval should be adjusted accordingly. Generally speaking, the interval varies between six and sixteen seconds.

The large number of carriers used, and the hard service to which they are subjected, makes the carrier maintenance account an important one in the total expense of operating the tubes. Carriers are sent to the repair shop daily for minor repairs, and then put back into service; but when the bearing rings are worn down to a diameter of about one-quarter of an inch smaller than the tube, then all the carriers are removed from service and an entire new set with full size rings is put on. In New York, where 1,900 carriers constitute a set, this change takes place once in about nine months. Carriers will travel from 12,000 to 15,000 miles on one pair of bearing rings, and they wear out on an average two pairs of rings before being condemned to the scrap heap.

Advantages.

The purpose of the tubes is to save time in the transmission of the mails between the central post-office, branch stations and railway depots; also to give a more uniform and reliable service than can be secured by vehicles running on the surface of the street. The speed of transit is higher than by any other means used. The speed of the carriers between stations is 30 mi. per hr., but the average speed between remote stations necessarily falls considerably below this, due to the delays of redispatching at intermediate stations. The committee appointed by the Postmaster General in 1908, to investigate the system, stated in its report: A number of tests were made in the several cities to ascertain the actual speed by tube per hour in transmission between the central post-office and the several other stations in each city, with the following results:

City.	Speed in Mi. per hr. Minimum.	Maximum.
Boston	14.7	25.1
New York	17.5	30.7
Brooklyn	28.2	30.0
Philadelphia	25.3	29.5
Chicago	24.8	30.0
St. Louis	25.5	30.0

The contract speed for transportation of mails by wagons ranges from three to five miles per hour, for street-car service not more than eight or ten miles per hour, and the maximum permissible speed for automobiles in cities is from six to twelve miles per hour. The actual average speed of surface traffic in congested streets is far below these figures, so that it is safe to say that the speed of pneumatic tube transmission is several times greater than any other means thus far used. It is by no means limited to 30 mi. per hr., but the expenditure of power is out of all proportion to the increase in speed when much higher rates are secured, particularly when the distance between power stations is great. In comparing the speed of carriers by tube with the speed of wagons or trolley cars, it must be remembered that the former is computed between the terminals, which are located in the post-offices, while the latter is computed between the platforms outside the post-offices, or, in the case of trolley cars, between the points at which they stop nearest the post-office buildings. Considerable time is consumed after the mails are pouched, in carrying or trucking the pouches to the wagons outside the buildings, and at the other end of the route in carrying or trucking them into the buildings.

Frequency of dispatch by tube results in the saving of much time and is of greatest value perhaps in hastening the delivery of special letters. These are forwarded immediately without waiting for the closing of regular mails. Within the tube area "special delivery" letters can be transmitted as quickly as telegrams, and the knowledge of this fact by the public generally should result in an increased use of these letters. The "special delivery" service, moreover, is not limited to letters, but extends also to parcels. Frequency of dispatch has the further advantage of giving more uniform employment to the postal clerks. Under the old system, when a wagon arrived at an office, there was a rush on the part of the clerks to distribute the mail, followed by a lull until the arrival of the next wagon. Under the tube system the mail is received in an almost continuous stream, and is distributed much more quickly.

The tube service expedites a considerable portion of the railway mail, both incoming and outgoing, particularly the latter, by rapid and frequent service between post-offices and railway stations. The conditions here are somewhat different than in the service between post-office stations, for the reason that the mails arrive and leave at infrequent intervals in large bulk.

The underground tubes are most appreciated during the severe snow storms that sweep over our northern cities nearly every winter, and almost completely block surface traffic. The tube service is also secure from interruptions due to street parades, fires, riots, etc.

The "Santa Fe-De-Luxe" is the name of a new train which is to go into service between Chicago and Los Angeles, via Kansas City and Albuquerque, on Dec. 1, according to an announcement made by the Atchison, Topeka & Santa Fe Ry. The train will be run once a week during the winter time on a 63-hour schedule, and with an extra fare charge of $25.

The Relation of Illuminating Gas to Public Health.

Illuminating gas, but more particularly water gas, in its relation to public health was considered some months ago in a paper by W. T. Sedgwick and F. Schneider, Jr., Massachusetts Institute of Technology, Boston, read before the Massachusetts Association of Boards of Health. Portions of the paper are printed in the "Journal" of the American Public Health Association for May, 1911 (Urbana, Ill.), and it is expected that the full paper, with tables and diagrams, will be printed in the "Journal of Infectious Diseases" (Chicago, Ill.).

The paper reviews the efforts which were made to prevent the sale of water gas in Massachusetts in the early '80s and which were successful until those interested in the old and new processes of gas-making came to terms. At first the old gas companies secured state legislation prohibiting the manufacture and sale of illuminating gas containing more than 10% of carbon monoxide. What Prof. Sedgwick describes as a "battle royal" was fought between the two opposing gas companies. The State Board of Health, Lunacy, and Charity having been brought into the controversy, the late Prof. William Ripley Nichols was requested by the Board to investigate the relative sanitary qualities of the old and new gas. Prof. Sedgwick, who had just come to the Massachusetts Institute of Technology from Johns Hopkins University, was invited to join Prof. Nichols in this work. Numerous experiments with animals readily proved the danger from water gas, but, as already stated, the opposing gas interests finally came together, and this being accomplished they "united in the repeal of the old law because it interfered with business." The law virtually prohibiting the sale of water gas was repealed in 1890.

The authors of the paper mentioned present statistics to show rapid increase in deaths from illuminating gas after the repeal of the law. They state

> that in the fifty years preceding the repeal of the law regulating the amount of carbon monoxide in gas, there were not half a dozen cases of gas poisoning outside the two or three where the gas was being used in Massachusetts in violation of the law. Since that time it is safe to say that there have been at least 1,200. Is not that a pretty high price to pay for the convenience of manufacturers?

The following paragraph from the paper, in which comparisons are made between deaths from gas poisoning and from scarlet fever and typhoid fever, will doubtless surprise many of our readers:

> In Rhode Island, in New York, in Pennsylvania, and elsewhere, but especially in the northern tier of states, gas poisoning is to-day a very serious cause of sickness and death; how serious may be judged by the following facts: The rate per 100,000 in gas poisoning in this state and in Rhode Island is now quite comparable with that of scarlet fever in some years, and measles, in others. For example, in 1905, in Massachusetts, the rate for measles was 5.9 and for scarlet fever 3.9, both of which figures are exceeded by some of the figures for gas poisoning. In 1909 the rate for measles in Massachusetts was 4.76 and that for scarlet fever, 7.86, figures again either exceeded or approached by the statistics of deaths from gas poisoning. As for infantile paralysis, about which we hear so much, gas poisoning is a far more serious cause of death to-day than that is, and ought to be taken account of correspondingly. It is not so alarming, because we know more about it. We are always alarmed by the things we don't understand; we are apt to be too little alarmed by the things with which we have become familiar. Let us compare gas poisoning with a disease like typhoid fever. Typhoid fever in Cincinnati this last year reached the rate of only 5 per 100,000. In Hamburg, Germany, it has been 4 and 5 per 100,000 for some time. In other words, more people are dying of illuminating gas in Rhode Island and Massachusetts than are dying of typhoid in Hamburg, and in many other places.

The conclusion of the paper as printed in the journal named is as follows:

> The remedy is the return to the use of the old-fashioned coal gas, which is still used in many places, and which by the testimony of gas men is not much, if any, dearer than the water gas, but which is much less convenient to make. It is argued by the gas men that the water gas has a higher candle power. So it has, nominally, according to the common methods of measurement, but all I can say on that head is this: I would like to go back to the old coal gas simply and purely on candle power. The old light was a better light than the light to-day. Although the light to-day may read 24 candles and the old one read only 16, I know that the old gas was a better gas for domestic use, and I would rather pay $1.50 a thousand, which I used to pay for the old coal gas, simply from the lighting point of view, and without any connection whatever with sanitary ideas, than to pay what I do now for the so-called 24-candle water gas.
>
> Massachusetts is entitled to credit for having required a record of cases of gas poisoning. She is not entitled to great credit for having repealed the 10% law. Gas has become in Massachusetts, and especially in Rhode Island, a very important cause of death, and it is our business as sanitarians to take cognizance of that fact and as opportunity offers to act upon it.

Estimating the Cost of Handling Freight Cars at Yards and Terminals.

It is well recognized that one of the principal items in the cost of freight transportation by rail is that of handling at terminals, and in the analysis of such cost it is desirable to separate the cost of transportation on the road from that of handling the cars at yards and terminals. It is a difficult matter, however, to determine this cost of yard operation, owing to the complicated character of the movements. In a report made by a committee of the Association of Transportation and Car Accounting Officers,* it is recommended that the cost should be arrived at by dividing the total cost of operation by the number of car movements into and out of the yard. This recommendation was not endorsed and adopted by the Association, as the method proposed does not take account of the various movements within the yard. The report, therefore, was referred back to the committee.

In view of the growing recognition of the importance of correct analysis of transportation costs, we give below an abstract of the report and the discussion which followed its presentation:

> Your committee has reported from time to time regarding uniform methods of computing average detention in yards; and has become convinced of the necessity for some uniform method of determining the average cost of handling cars in a yard or through a terminal, in order that the statistics which are hereafter kept of these movements on various roads may be utilized for comparative purposes. Your committee would therefore present the following:
>
> The preparation of statistics showing the average cost of handling cars through a terminal yard, so far as the item of "number of cars" is concerned, should be based upon the figures obtained by counting the cars inbound from the conductors' train reports and from the received side of the interchange report; also cars outbound from the conductors' train reports and the delivered side of the interchange report. The total number of movements of cars thus obtained shall be called the "number of cars" and shall be divided into the total cost of operating the terminal. The average cost obtained by this method will represent the average cost of handling a car into or out of the yard or terminal. Therefore, in order to obtain the average cost of moving a car through the same yard or terminal, it will be necessary to add the cost inbound to the cost outbound. For example:

Total car movements	93,117
Cost of operation of terminal	$25,700
Av. cost of movement into terminal yard or out of terminal yard	27.6 cts.
Total av. cost of movement into and out of terminal yard (two movements)	55.2 cts.

Mr. Taylor (Southern Ry.).—What consideration has been given to the handling of cars within the terminal? If we are to arrive at comparative statistics that will be of benefit in determining operation, it seems to me to be very vital that the question of number of cars handled within the terminal be taken into consideration, as well as cars inbound or outbound.

*Report of the Committee on Conducting Freight Transportation, Proceedings of the 15th regular meeting of the Association of Transportation and Car Accounting Officers, held at Cape May, N. J., June 20, 1911. Secretary, G. P. Conard, 75 Church St., New York, N. Y.

Mr. Wrenne (N., C. & St. L. Ry.).—If all cars coming into the yard and all cars going out are counted, you cannot get a better basis. If you commence making a note of each individual movement of every car while in the station, there is no end to it.

Mr. Taylor.—In determining the number of switch engines required for handling traffic within a terminal, what consideration is given to the amount of work required? How is the capacity of an engine arrived at? Is any consideration given to the number of switch movements made within the terminal, in arriving at the average cost for handling (cost within the terminal)? Is not that an important feature in arriving at the information that is desired for comparative purposes?

Mr. Wrenne.—We get the same information by the cars handled in and out of the station. Of course, those matters do not and cannot come in correctly, because there is no very good way to get at it. It is only an estimate. So we think that for all purposes this method would be quite sufficient.

Mr. Clark (C., B. & Q. Ry.).—We have made station statistics for several years, and while the basis the committee recommends will make a comparison from month to month for the same station, it will not make a basis of comparison as between that station and other terminals as to the cost of handling cars. For instance, on the Burlington Ry. we move through Galesburg, Ill., from 5,000 to 8,000 cars a day. Quite a proportion of the trains on arrival have, say, one car switched out and another car added, crews and engine are changed and the train goes on. According to the recommendation of the committee we would have to count each of these cars in and out while on many of them practically no yard movement was made, yet they must be counted because the train requires the services of a switch engine. When that train arrives at Chicago it is necessary to make from one to six or eight movements of each car by switch engine. You could not say that the cost of handling at Chicago on this basis could be compared with the cost of handling at Galesburg.

Mr. Higbee.—When a car goes into a terminal you should inquire as to the cost of that car until it gets out. And one movement only should be counted. Suppose you handle one car at a terminal. It costs you $1 to handle that car. Under the committee's plan you would be handling two cars and it would cost you 50 cts. a car.

Mr. Bell (Penna. R. R.).—I presume this refers to intermediate yards as well as terminals, and if we expect to get real results we have got to do something more than simply arrive at the cost. We have got to systematize checks to show how long the cars are in the yard, in order to keep them moving. I believe it is essential to know what general movements these cars are making in the yard. To get behind the car and keep it going. We inaugurated a system of checks through our terminals and yards which did facilitate the movement. It did get us results which we would not have got had we simply arrived at a basis of cost and stopped there.

Mr. Wrenne.—No two yards can be operated with the same cost for each car in the yard. To arrive at the cost in any yard some system must be adopted and method got at, but the cost of one yard would be different from the cost of another. We thought the number of cars into the yard and out of the yard would be the proper way to get at the basis. If you get that, and find the cost is too great, it is up to the management to find out why and how this extra cost comes in. To follow the individual movement of each car would be altogether different in different yards, consequently we did not think it necessary to go into that.

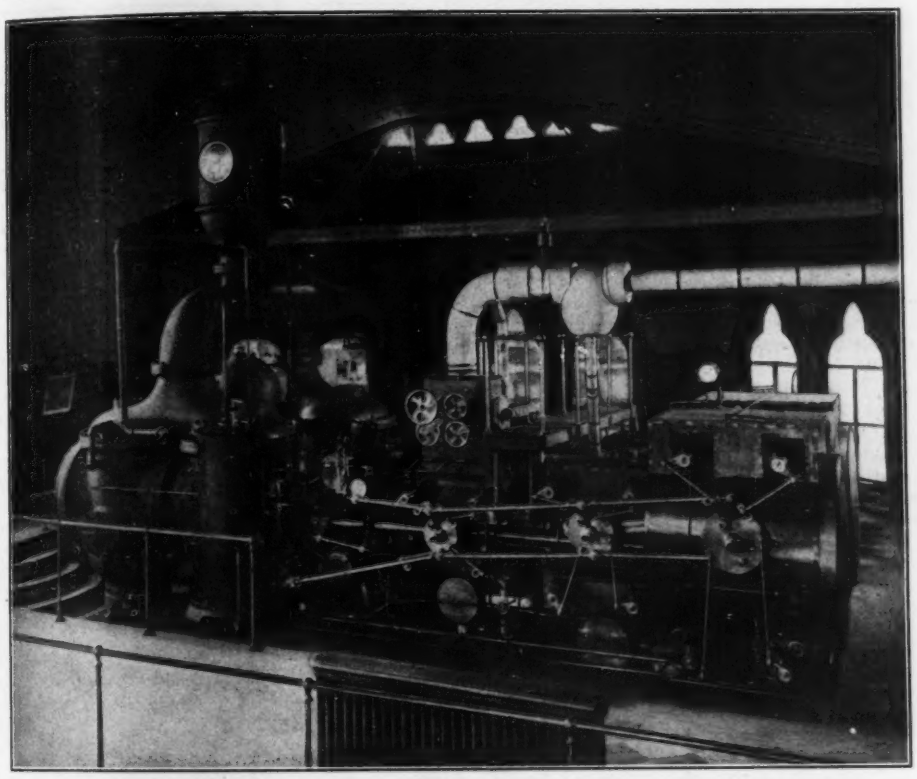
Mr. Taylor.—Some such a system would be invaluable to any road, and if the committee would like to have some information on this subject, it will afford me pleasure to give them some, because I have it. The item of cost or expense is probably one of the most live subjects that there is before the railways to-day, and this particular feature is one of such importance that I scarcely believe this Association is prepared to adopt this report now, for the reason that, in my judgment, it is not complete, and does not give the comparative information that is necessary.

The Irrigated Area of South Dakota was 63,248 acres in 1909, according to statistics collected by the U. S. Census. The corresponding cost of the irrigation systems was $3,043,186 or $2,369 per acre. Of the total area, 5,613 acres, or 8.9%, was covered by works built by the U. S. Reclamation Service, and 50 acres were under works built by the U. S. Indian Service.

An Interesting Design of High-Duty Pumping Engine.*

In July, 1909, the city of Providence, R. I., issued specifications and a call for bids for a 10,000,000-gal. pumping engine to replace an old Nagle unit. This engine was to operate on a steam pressure of 150 lbs. gage against a discharge pressure of 65 to 75 lbs. and a suction pressure of from −10 to +15 lbs. The engine was to be guaranteed against damage from quick changes of water pressure in suction or discharge lines as caused by sudden closing of a gate or hydrant, or by a break in a main. In September, 1909, the contract was awarded to Henry R. Worthington and the unit was put into service in the summer of 1910. Acceptance trials were run in September of that year and the unit has been in continuous service.

The engine, shown in the accompanying figure, combines many of the features evolved for various earlier designs of the builders. It is a duplex direct-acting self-contained triple-expansion high-duty type with the three cylinders of each side arranged in tandem. Each set of steam cylinders is directly connected to one double-acting water plunger by a special three-rod arrangement in which the plunger rod extends through the main cross-head into the high-pressure cylinder, carrying the high-pressure piston only. The low-pressure piston is connected to the main cross-head by means of two side rods having the high and low-pressure cylinders between them. A central piston rod attaches the low-pressure piston to the intermediate pressure piston. The arrangement is such to insure quick and easy access to each of the pistons by removing their respective cylinder heads, without disturbing any other portion of the engine.



A 10,000,000-GAL. HIGH-DUTY PUMPING ENGINE WITH MODIFIED CORLISS VALVE GEAR.
(Built by Henry R. Worthington, New York City.)

Both steam ends of the engine are connected to the water ends by heavy cast-iron housings, which hold slides for the main cross-heads and journals for the oscillating cylinders of the high-duty attachment. Each steam cylinder has two admission valves on top and two exhaust valves on the bottom. All are of a Corliss type modified so as to be applicable to direct-acting pumps. The exhaust valves are operated directly from the wrist-plate of the main valve gear, as may be seen in the accompanying figure. This receives its motion from the cross-head of the opposite side in the manner of the duplex valve gear. The admission valves, however, are provided with a quick-acting non-release auxiliary cut-off gear which is interposed between the wrist-plate and the valve spindle cranks. It is seen that the admission valves of each cylinder are connected to a four-arm crank fulcrumed on the wrist-plate and receiving motion also from the cross-head on its own side of the engine. It is seen that the main and auxiliary (upper and lower) parallel links between these wrist-plates may travel in opposite directions and changes of relative travel may be timed so that, during admission, the motion imparted to the admission valve, is largely that given by the rotation of the wrist-plate, while during release the movement of the auxiliary gear is added to the travel of the wrist-plate to give a quick cut-off without necessity of a release drop.

The high-duty attachment is of the standard design of these makers, each side of the engine having two oscillating cylinders whose trunnion journals are carried by the housings. These cylinders are perpendicular to the main guides at mid-stroke and contain plungers attached to the main cross-head. The cylinders are under constant pressure received from the discharge line of the engine, but increased to the required amount by an interposed differential accumulator. During the early part of the stroke, advance of the piston rod is resisted and energy is supplied to the accumulator to be paid back during the latter part of the stroke. By thus alternately absorbing and repaying power these cylinders, due to the different angle through which the force is applied in relation to the motion of the piston, perform the function of a flywheel and the force they exert increases almost exactly by the same ratio as the decrease of force of the expanding steam.

Prevention of short-stroking under variable load is secured by an attachment which automatically changes the back pressure of the accumulators of the compensating cylinder, so that this cylinder has its load increased or decreased as required, tending to lengthen or shorten the stroke of the engine.

The pump ends are of the sectional plunger-and-ring type with suction and discharge chambers bolted to the pump barrels. These are provided with horizontal valve decks containing multiple water valves of small diameter but of sufficient total area to ensure quiet operation.

All of the water pumped by the engine passes through a surface condenser which is placed in the main discharge line resting on the floor of the engine room. An independent crank-and-flywheel type of air pump is used, located in the basement and exhausting into an auxiliary feed-water heater.

The contract with the City of Providence specified that when pumping at the rate of 10,000,000 gals. per 24 hrs. (plunger displacement) against an average pressure of 65 lbs., the duty should be 135,000,000 ft. lbs. per 1,000 lbs. of dry steam, and when pumping at the rate of 7,000,000 gals. per 24 hrs. against the same pressure the duty should be 120,000,000 ft. lbs. per 1,000 lbs. of dry steam. This duty was to be computed on the difference of the heat units of the steam at the throttle and in the feed-water returned to the boilers.

The principal data and result of the official trials are given in the accompanying table.

The duty exceeded the guarantee by 4.57% at full load and by 12.5% at reduced capacity, not including the allowance for heat returned to the boilers as noted in the contract. With this allowance the engine would show a duty of 149,500,000 ft. lbs. per 1,000 lbs. of dry steam at full load and 142,000,000 ft. lbs. at reduced capacity. These figures would exceed the guarantee by 10.5 and 18%, respectively. Additional trials were made by pumping into the open service with suction from a reservoir and again from the street mains. It was likewise tested by pumping into the closed service lines while taking water from a reservoir and again taking from the street mains. The city also made a test in conjunction with the fire department to ascertain the action of the engine in case of fire, while pumping both into the open and closed service. A number of streams from street hydrants were suddenly opened, but without effect on the engine.

*Arranged from information prepared by Mr. William Schwanhausser, for the International Steam Pump Co., 115 Broadway, New York City.

TESTS OF A HIGH DUTY PUMPING ENGINE AT PROVIDENCE, R. I.

Test No.	1	2	3
Dates of Trials, 1910	Sept. 1	Sept. 2	Sept. 2
Duration, Hrs.	6	3	4
Steam Pressure, lbs. per sq. in	151.4	151.2	151.9
Vacuum, ins. mercury	27.45	27.67	27.75
Discharge Pressure, lbs. per sp. in	73.14	79.94	73.64
Suction Pressure, lbs. per sq. in	5.13	5.70	6.37
Total Pressure Pumped Against, lbs. per sq. in	67.54*	73.70*	66.72*
Average Stroke of Engine, Ins.	24.75	24.68	24.77
Revolutions of Engine	14,175.	4,899.	6,178.
Revolutions per Minute	39.38	27.22	25.74
Piston Speed, ft. per min.	162.4	112.	106.3
Capacity, Rate mil. gal. per 24 Hrs.	10.85	7.48	7.10
Total Steam Used, lbs.	25,422.	9,832.	11,475.
Moisture in Steam	1.71%	2.38%	2.38%
Total Dry Steam Used, lbs.	24,987.	9,598.	11,202.
Duty per 1,000 Lbs. Steam Used, mil. ft.-lbs.	138.6	135.	132.6
Duty per 1,000 Lbs. Dry Steam, mil. ft.-lbs.	141.	138.3	135.8
Water HP.	296.7	223.5	192.
Dry Steam per Water HP. per hr., lbs.	14.04	14.31	14.59

*Includes distance head between gages.

The Irrigated Area in North Dakota in 1909 was 10,248 acres against 4,872 ten years earlier, or an increase of 110%, according to preliminary figures of the U. S. Census. The total cost of irrigation systems in North Dakota on July 1, 1910, is reported as $789,533, as against only $16,980 in 1899. It will therefore be seen that the irrigation works in use ten years ago were of a relatively expensive character.

The New High-Speed Cableways on the Panama Canal.

As a part of the scheme to develop the highest efficiency in all parts of the work on the Panama Canal, the specifications for the cableways used in the construction of the Gatun locks and at other places on the Canal called for a capacity which required a carriage speed of 1,800 ft. per minute, which was about twice the speed obtainable from the best carriers then in use. Not only was this high speed required of the carrier, but it was imperative that the machines work to the highest efficiency with the least possible percentage of breakdown, for on this work involving

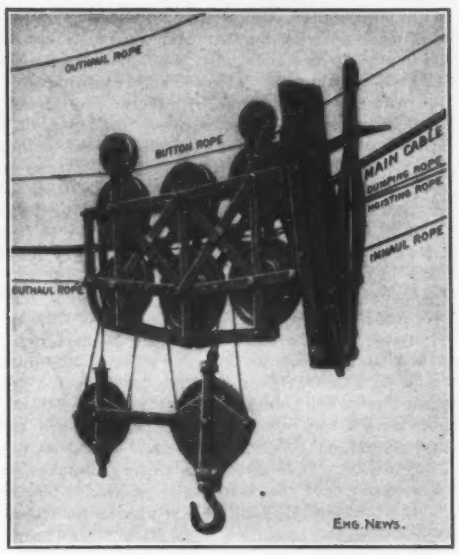


Fig. 1. The Old Type of Lidgerwood Carriage for Four Rope Cableways.

the moving of so much material the slightest delay soon mounts high in cost. For instance, on the Gatun locks, where the greatest number of cableways are installed, the engineers have computed that the loss for each minute the cableways are out of service for repairs during working hours amounts to $1.50. This includes the losses for labor, depreciation, interest and overhead charges. Thus if each cableway were out of service only ten minutes per day, in a year of 300 working days the total loss for the eight cableways would amount to $36,000. It is thus evident that stability and endurance are as much a necessity for the cableways as is speed.

The contract for the 13 cableways to be used on the Canal was awarded to the Lidgerwood Mfg. Co., New York, and the machines which they installed have now been in operation for about two years, with a high efficiency as regards breakdowns. They have also fulfilled the requirements as to speed. In order to do this, however, a new design of carrier was made, involving a number of detailed changes, which tended both to increase the speed and to decrease the wear and breakage.

For a number of years the Lidgerwood company has been making a cableway carrying a fall-rope carrier, approximately after the design shown in Fig. 1. In this type of cableway, the carriage runs on a main cable, is controlled in either direction by haul ropes, and the fall is operated by a fall rope which is held in approximate parallelism to the main cable by a series of carriers which are spaced by a "button-rope" cable, and are picked off the main carriage by buttons fastened along the "button rope" at intervals. These carriers normally hang on a horn at one end of the carriage and are provided at their upper end with slots of graded sizes, corresponding to graded dimensions of the buttons, so that each button will pass through every carrier except the one that it is intended to be pulled off the horn. Thus, as the carriage runs out along the cable, the fall rope is held from the natural sagging that would prevent the operation of the fall, and as the carriage returns toward the engine, the carriers are picked up successively by the horn. The button which was used on the old style of fall-rope carrier is shown in Fig. 2. It was in two parts, secured together over a portion of the cable enlarged by the insertion of a metallic spreader.

These machines worked fairly effectively up to a speed of 800 ft. per min., but above that speed the repair losses became so great as to be burdensome. The difficulty seemed to be in the form of button, the manner in which it was held in place on the button rope, and in the shape of the carrier heads which collided with the buttons. The button was long and conical and entered wedge-like into a slot in the carrier head. The carrier heads were slotted in forged steel, but no matter how heavy they were made, the impact effect seemed to increase in proportion to the weight and the wedge-like buttons split the heads. The impact on the buttons was also destructive to the button ropes. These had frequently to be renewed. As shown in Fig. 2, the button was made in halves, divided lengthwise, and screwed together. It enclosed a pair of spreaders put into the rope and a babbitt metal bulge cast around the rope within the button. The surface of the rope which received the shock was so small that the wires were soon cut and the ropes destroyed.

In the Panama cableways the high speed required necessitated many improvements over the old type described above. The button (Fig. 4) was first improved. Instead of being made of two pieces it is now practically a single steel forging bored out with a long tapering recess. The rope is made to fit this recess for its entire length by inserting in the rope a properly tapered steel pin in place of the hemp center. This gives a bearing of such large area to receive the shocks from the carriers as to prevent any tendency to cut the rope. A follower fits into the open end of the button and serves to finish its contour. This is held in place by a small spreader inserted in the rope back of it. These buttons and the rope carrying them have withstood without damage months of use at the company's cableway testing station, where for long periods the carriage speeds have been run up to 3,000 ft. per min.

The next and most revolutionary improvement was in the form of the fall-rope carrier head (Fig. 3). This was changed from a slotted head to a steel eye. As the eye comes in contact with the end of the button around nearly the whole circumferential face instead of at two points only, all splitting tendency was at once eliminated. Weight was also saved, as the eye weighs but a tenth part of what the slotted head did. It was also necessary to hang the eye in the carrier so that the eye was free to swing when it was picked off the carriage. This was found to absorb a considerable part of the shock. A second joint was introduced in the carrier head below the eye. With the two joints the shock is so thoroughly absorbed that its destructive effects at speeds up to 2,000 ft. seem to have disappeared. This is the form of the present Lidgerwood fall-rope carrier.

Incidental to and following these changes, improvements of importance were made in the carriage. The horn which carries out the fall-rope carriers to the buttons and picks them up again upon the return trip of the carriage is mounted separately from the carriage with its own wheel running on the main cable. The horn's mounting is connected to the carriage with a pivoted connection so that the horn always keeps a position in line with the cable no matter what the curve of the latter may be. This ensures the picking up of the carriers and this with the least shock, since the horn enters them always at the same point.

The carriage proper has three bearing wheels on the main cable. Two of these are mounted

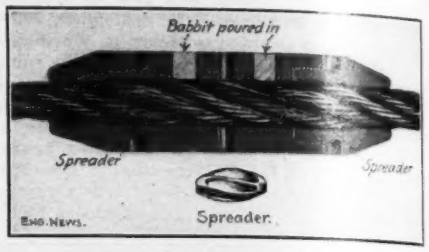


Fig. 2. The Old Type of Button.

in a pivoted bearing so that they can adjust themselves always to the varying curves of the cable. This distributes the weight and the wear equally between these two wheels and contributes considerably to the life of the main cable. The increase in economical load carriage speeds from 800 to 900 ft. per min. to 1,600 to 1,800 ft. has nearly doubled the capacity of the cableway.

A recent report from the Isthmus states that the eight cableways used for placing the concrete in the locks have been out of service for repairs of all sorts but 1% of the total working time for nearly a year's continuous use. This is based on a working day of 10½ hrs. and a loss of 7.5 mins. per day. On the Chicago Drainage Canal, the largest single operation where cableways have been employed, the 20 old-type Lidgerwood cableways showed for the first few months an average loss of time for repairs during working hours of about 45 mins. each per working day at 10 hrs. On the basis of the Panama report this would make a difference in efficiency of 6½% in favor of the Panama cableways, or putting it into dollars and cents the

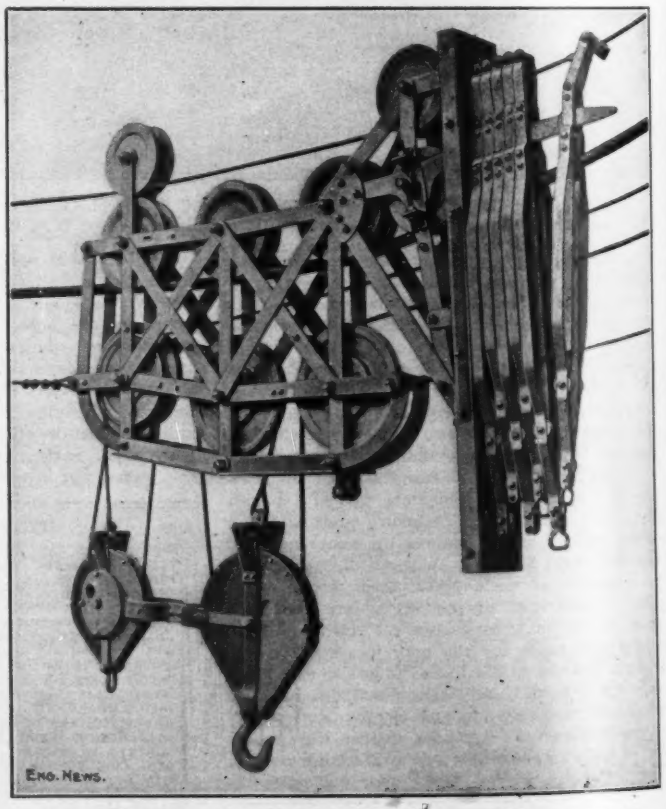


FIG. 3. THE NEW CARRIAGE FOR THE HIGH SPEED PANAMA CABLEWAYS.
[Invented by Spencer Miller; Manufactured by the Lidgerwood Mfg. Co.]

Panama cableways have an actual earning capcity of about $20,000 a year each more than those first used for the Drainage Canal.

We are indebted to the Lidgerwood Mfg. Co. for the information upon which this article is based.

Some Late Types of Dredges Built in Clyde Yards for Foreign Service.

By GEORGE THOW.*

The Clyde has acquired a reputation for the building of dredges. Certain firms have for a long period of years specialized in this branch of the shipbuilding trade, and supply dredges of all types—bucket, suction, and suction cutters, also gold dredges and rock cutters—to all parts of the world. Some particulars may be given of recent important orders in the hands of these firms, placed by American and other buyers, with particular reference to novelties in design.

For the Panama Canal a very powerful dredge has just been completed by Wm. Simons & Co., Ltd., of Renfrew. It is a twin-screw hopper bucket dredge and is constructed to the order and requirements of the Isthmian Canal Commission. This dredge, which will be employed in doing some of the very hardest cutting in the Canal Zone, is fitted with two sets of dredging buckets, one for clay and one for mud. It will cut its own flotation and dredge to a depth of 50 ft. below the light water line where the ladder makes an angle of 45° with the vertical. It is designed to dredge either direct into its own hoppers or into barges alongside. The dredging gear is arranged to give two different speeds of buckets per minute with a constant piston speed of engines so that the full power of the engines is exerted whether the vessel is working on hard or soft ground. Two steel cylindrical multitubular boilers are fitted on board, and either boiler is capable of supplying steam to the engines and all auxiliaries when at full work.

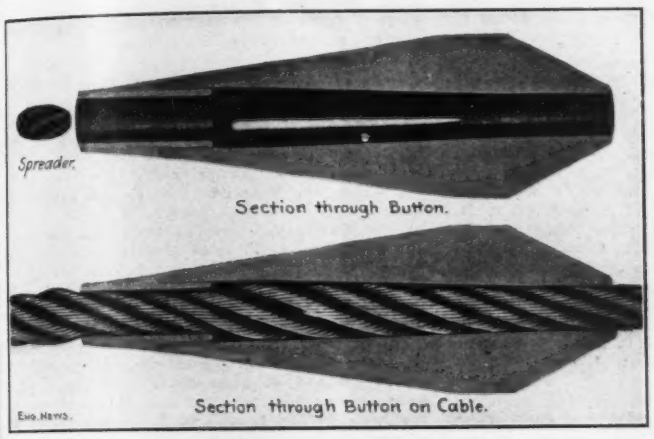


FIG. 4. THE NEW TYPE OF BUTTON.

This dredge has two sets of propelling engines of the triple expansion surface condensing type and of sufficient power to drive the vessel at a speed of 10 knots per hour. Powerful independent winches are fitted at bow and stern for maneuvering the ship while dredging and for raising and letting go anchors. The hopper doors are controlled by hydraulic power. For efficient lighting above and below deck a complete installation of electric light is provided, and in general the vessel is equipped with the most up-to-date appliances.

In regard to the suction type of dredge, to which attention is being greatly directed at present, with or without the auxiliary cutter, a dredge was sent recently from the Clyde to Buenos Ayres to the order of the Argentine Government, one of the new trailing suction hopper design. When dredging in the Punta del Indio this vessel lifted and transported in 21½ days, 784,800 cu. yds. of clay. This represents almost 49,000 tons dredged and discharged per day. It is claimed by the builders that this vessel is the largest and most powerful of the type yet constructed. The suction and self-discharging pumps are extremely powerful. Four sets of triple-expansion surface condensing engines are fitted on board in such a way that all four sets are available either for propelling or pumping as may be required. Steam is supplied from four cylindrical multitubular boilers, and one cylindrical multitubular donkey boiler, at a working pressure of 160 lbs. The auxiliaries in the engine room include independent main condenser, independent steam-driven air and circulating pumps, feed, bilge, and service pumps, feed heater, filter and evaporator, and auxiliary condenser with independent air and circulating pumps. The main centrifugal pumps are connected to a suction frame fitted in a central well at the stern. At the bottom of the suction pipe water jets are arranged. The hopper doors are controlled by very powerful hydraulic gear, the power being supplied from two duplex sets of steam pressure pumps. Steam hoist gear is provided for controlling the lower end of the suction frame.

The hopper arrangements include Simon's patent suction keelsons, which enable the load to be discharged overboard for reclamation purposes, a system which is now being adopted in India, Japan and the Colonies, either with a floating pipe line or an overhead long-shoot line.

A dredge sent to Bombay from the Clyde is in use by the Bombay Port Trust and is fitted with pumping plant capable of dredging 2,700 cu. yds. of material per hour and of discharging this spoil through floating and shore pipes to a distance of 4,500 ft. This vessel and a sister ship are employed by the Bombay Port Trust in carrying out a gigantic reclamation scheme whereby land will be reclaimed from the sea and low-lying land raised to a higher level.

Letters patent have been taken out by Messrs. Simon for this special type of suction hopper cutter dredge fitted with a suction pipe and cutter. At the lower end of the suction frame is fitted the spiral rotary cutter driven by steel spur gearing by a set of compound surface condensing engines. The control of the dredge is centered on the operating bridge, and one man can control and direct all the operations of the dredge and the pipe line by means of telegraphs, speaking tubes, or signals to cutter engines, pumping engines and stern winches. The handles for controlling the frame-hoisting gearing at the bow winch are on the bridge. It is claimed for this new type of vessel with its special fittings that it can in most cases do the same duty as a dredge fitted with a bucket ladder and chain of buckets. It will, however, be less costly in maintenance and repairs, and as it has no upper or lower tumblers, buckets, links or pins, it has fewer wearing parts than bucket dredgers.

This new class of suction dredge can lift very heavy material. One, sent out to New Zealand by the Paisley firm of Fleming & Ferguson, picked up with her suction pipe boulders weighing up to a hundredweight and of sizes 22 by 12 by 8 ins. The dredges working at Bombay have discharged heavy pieces of stone and flint; one boulder caught by the deflector at the end of the pipe line weighed over 400 lbs.

In designing the pipe lines to deliver the material ashore the method adopted at Rangoon and also at Bombay is to have the line carried on a series of pontoons placed 50 ft. apart. A new contrivance is employed at the joint between each pair of pontoons to permit of lateral and vertical movement in the line of pipe. Formerly either rubber or leather jointing was employed, but owing to the heavy nature of the service these joints had a very short life. The introduction has been made of the ball-and-socket joint of cast steel, which gives the maximum freedom of movement in every direction and provides an absolutely watertight joint, special packing being employed on the outer edge of the joint.

For bucket dredges the Clyde builders have fulfilled numberless orders, and this is a class in which they have for years specialized. At present one of the firms is building a large vessel of the very latest design for the Clyde Trust. An interesting dredge of the bucket type is at present in operation on the Tone River, Japan. It was constructed by Lobnitz & Co., of Renfrew, and delivers the dredged material by a very long overhead chute to the river bank. On the Manchester Canal is an overhead long chute suction dredge doing the combined work of deepening the channel and reclaiming low-lying, marshy ground on the canal banks. It is also a Lobnitz boat. Not only can it dredge direct from the canal bottom, but it can pump out barges alongside and deliver the material on shore by the long chute which has affixed to it Fox's patent mouthpiece.

What is claimed to be the largest bucket dredge afloat is at work in the Suez Canal, and over a hundred vessels have been supplied to the Suez Canal Co. by the builder, Mr. Lobnitz. These bucket dredges have long lives. Two vessels sent out under their own steam to Brazil in 1871 are at work yet although the hulls had to be replated about eight years ago. They have been in constant use all that time.

A very powerful, in some respects unique, dredge of the patent cutter suction hopper class was supplied to the British Admiralty and began work early this year at the great naval harbor of Portsmouth. The suction pipe is carried on a girder led through a well forward and is of sufficient length to enable dredging to be done at a depth of 65 ft. below water line. The cutter at the mouth of the suction pipe is driven through a line of shafting, fitted on the upper side of suction frame, and machine-cut steel gearing actuated by a set of powerful independent compound condensing engines. This vessel, in addition to loading into its own hopper of 2,000 tons capacity, can discharge through doors in the ordinary way, or into barges moored alongside, or through a pipe line. It is understood that the results in stiff clay working are quite double those obtained by bucket dredgers. The pump is of the most massive description, to withstand the shocks that may be sustained when dredging in clay mixed with stones, and the vessel is designed to cut its own flotation. Two sets of triple-expansion surface condensing engines are fitted aft for propelling the ship at a speed of 10 knots per hour.

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The Manufactured Products of Detroit, Mich., in 1909, are summarized by the U. S. Census in a preliminary statement just issued, as follows:

	Census— 1909.	Census— 1904.	Per cent. of increase 1904-1909.
Number of establishments	2,036	1,362	49
Capital	$190,125,000	$91,038,000	109
Cost of materials used	$130,218,000	$66,581,000	96
Salaries and wages	$58,267,000	$28,684,000	103
Miscellaneous expenses	$26,743,000	$15,858,000	69
Value of products	$252,992,000	$128,247,000	97
Value added by manufacture (products less cost of materials)	$122,774,000	$61,666,000	99
Employees:			
Number of salaried officials and clerks	13,026	5,923	120
Average number of wage earners employed during the year	81,011	48,483	67

These figures do not include steam laundries, which, in 1909, numbered 35 establishments, with a combined capital of $672,000, a "valuation of products" of $1,346,000, 175 salaried officials and clerks and 1,508 wage earners.

The Official Progress Report on the Removal of Wreck of Battleship "Maine."*

The removal of the wreck of the "Maine" from the harbor of Havana is being carried on under the Acts approved May 9, 1910, June 25, 1910, and March 4, 1911, appropriating sums for the work which aggregate $650,000. On Aug. 2, 1910, a Board consisting of Col. W. M. Black, Major M. M. Patrick (now Lieut. Col.), and Capt. H. B. Ferguson (now Major), [all officers in the Corps of Engineers, U. S. A.—Ed.] was appointed and charged with the conduct of the work. The Board held its first meeting in Washington on Aug. 29, 1910, and formulated a general plan for the conduct of the work, appointing its junior member, Major Ferguson, as Executive Officer, with a recommendation that he should take station in Havana and have personal supervision of the work. This recommendation was approved, and Major Ferguson arrived at Havana, Sept. 9, 1910, the Senior Officer having arrived on Sept. 7, and having made certain preliminary arrangements with the officials of the Republic of Cuba, with the assistance of the Hon. J. B. Jackson, U. S. Minister. The two senior officers of the Board retained their stations and duties in the United States and visited Havana from time to time as their presence there seemed necessary.

LOCATION OF WRECK.—The harbor of Havana is formed by an indentation in the north shore of Cuba. It is shaped like a fan, of which the handle is the channel of the entrance. The general line of the coast at Havana trends N. 65° E. and the direction of the channel of entrance is N. 125° E. The length of this channel from the entrance at La Punta to the Castillo de la Fuerza, where it widens into the base of the fan, is 4,000 ft.; and its general width between the shore lines is 1,300 ft. and between the 18-ft. contours, 800 ft. From opposite La Fuerza the north shore of the harbor turns abruptly to the east, and the south curves gradually until its trend is southwest. The greatest spread of the harbor (in a northeast-southwest direction) is 14,000 ft. and its length from La Fuerza to the general line of the head of the harbor, which is formed by a deeply indented line trending northeast-southwest, is 7,400 ft. The harbor is surrounded irregularly by high land on all sides, in which limestone rock crops out at the surface. These facts are of interest since they show why the wave action within the harbor is so small, rarely if ever exceeding 2 ft. in height, even when the top of the lighthouse on Morro Castle at the entrance, 144 ft. above sea-level, is obscured by spray.

The mean tidal range is slightly over 1 ft. The extreme tidal range found was about 2½ ft. The harbor bottom is generally of clay, containing in parts strata of soft rock. In parts of the harbor the clay is overlaid with mud. Near the site of the wreck of the "Maine" the general depth of water was 35 ft. For the first 15 to 20 ft. of the harbor bottom the clay was soft and mixed with shells and coral sand. Below the depth of 60 ft. the clay is very tough. Rock was found at depths of from 98 to 118 ft.

PRELIMINARY STUDIES.—The United States Battleship "Maine" was sunk in the harbor at 9.40 on the evening of Feb. 15, 1898, as a result of one or more ebplosions, while lying at a regular mooring buoy (then numbered 4) 1,575 ft. east of the south end of the Machine Wharf and 3,100 ft. southeast from La Fuerza. The wreck lay with the bow pointing toward the Machine Wharf, and with the mainmast, the after searchlight platform, wreckage covering the amidship superstructure and a few pieces of isolated wreckage forward, appearing above the level of the water surface. Measurement shows that the keel aft lies at a depth of approximately 48 ft. The depth at which the keel lies at the bow is unknown. Immediately after the disaster a careful investigation was made by a Board of Naval Officers. The proceedings of the Board, accompanied by a number of photographs and sketches, was transmitted to Congress by President McKinley on March 28, 1898, and is printed in a public document entitled: "Message from the President of the United States Transmitting the Report of the Naval Court of Inquiry upon the Destruction of the U. S. Battleship 'Maine' in Havana Harbor, etc."

From the acts of Congress and the reports of the debates while the appropriations for the removal of the wreck were pending, it became evident that in addition to the removal of the wreck from the harbor, Congress desired (1) that the remains of the men who went down with the vessel and which had not been recovered should be found if possible and removed to the Arlington National Cemetery for burial; (2) that the mainmast of the ship should be sent to the Arlington Cemetery and there re-erected; (3) that the wreck should be so exposed without derangement of its parts as to permit all information possible to be obtained as to the nature and location of the explosion or explosions which caused the disaster.

Many plans had been suggested to the Department for removing the wreck. Those which showed sufficient thought and knowledge to render them worthy of consideration were of two general classes—(a) plans which contemplated the lifting of the wreck bodily from the bottom by chains passed under the keel actuated by mechanical devices so that the parts could be lifted and then floated by their own buoyancy or by auxiliary floats; and (b) those which provided for surrounding the wreck by a cofferdam, removing the water, exposing the wreck and then removing it.

After a careful consideration, and with such personal knowledge as could be obtained by a study of the printed Message of the President and an inspection of the wreck, the Board decided that any plan which contemplated lifting the wreck bodily, even if possible, would lead to such distortion of the broken parts so as to defeat one of the objects which Congress had in mind in directing the work to be done. This consideration led to the rejection of all of the plans of that class.

DETAILS OF SCHEME ADOPTED.—The Board then had careful studies made of designs for a cofferdam which could be erected at a minimum cost, with materials available, in the open harbor, on a clay foundation, and which would be able to resist the pressure of a head of 50 ft. of sea water and soft clay. The design which approved itself to the Board as most economical and advantageous under the conditions at Havana and which was finally adopted, was of a dam elliptical in shape, composed of cylinders 50 ft. in diameter, built of interlocking steel sheet-piles, driven to a depth of 73 ft.; with the cylinders placed tangent to each other, connected on the outer perimeters by short arcs of similar sheet piles, and with the cylinders and connecting sections filled with stiff clay from the harbor bottom nearby and rock. The centers of the cylinders were to be on a perimeter of elliptical form, with major and minor axes of 395 ft. and 216 ft. length respectively. The project further proposed to unwater the dam; to expose the wreck; to remove all remains found, articles of personal property and such parts of the stores and equipment as might be worth salvaging; to remove the destroyed portions of the vessel piece by piece; to bulkhead any portion of the ship sufficiently intact and then to float that portion and dispose of it as higher authority might direct. On account of the many uncertainties involved in the work, which might require radical changes of plans as the work progressed, it was deemed most economical and advantageous to have the work done by hired labor, with materials purchased and plant hired under contract after inviting proposals, or in open market as prescribed for works of river and harbor improvement.

This project was submitted to the Secretary of War by the Chief of Engineers, Oct. 10, 1910, and on the same date was submitted to the President, by whom it was approved, Oct. 13, 1910.

The President of the Republic of Cuba and his Cabinet Officers made every effort to facilitate the work of the Board. Customs duties were ordered remitted on all materials and machinery required for the work. Wharf and storage space at Casa Blanca belonging to the Republic were allotted. A number of pieces of floating plant were loaned free of rental, including a dredge, tug boat, floating derrick, drill boats and dump boats. The Secretary of Public Works, Senor Joaquin Chalons, further offered the services of such of his engineers as might be required and such other aid as his Department might be able to give.

Progress of the Work.

The first work was an examination of the surroundings of the wreck. Its location in the harbor has been described earlier. The general direction of the keel is S. 82° W., looking toward the bow which points toward the Machine Wharf. The forward portion seems to be out of line with the after part. The nature of the bottom found has been stated above; i. e., depth of water 29 to 35 ft.; soft mud composed of red clay and shell to depths of 55 to 58 ft.; hard blue [illegible] to 81 ft.; stiff yellow clay and mud 98 to 118 [illegible]. Isolated pieces of wreckage were found prin[illegible]ly around the forward half of the ship, to di[illegible]ces of 75 ft. from the keel line on the port s[illegible] extending to 70 ft. beyond the bow; and on [illegible] starboard side to distance of 120 ft. The sh[illegible] foremast was found with its fighting top 4[illegible] forward of the bow, measured along the [illegible] line extended, and 22 ft. to port from t[illegible]me line. The base of the mast was further [illegible]ward and further to port. The angle betwee[illegible] lines of the keel and mast, respectively, was [illegible]bout 28½°. Wreckage which when removed la[illegible] was found to consist of the starboard turret [illegible]od, turret top, and a large anchor, was found [illegible] the outer perimeter of cylinder N, 75 ft. forward and 100 ft. to starboard (measured on the [illegible] of the keel and at right angles thereto) from the position of the turret in the hull. The [illegible] is a disk of steel 25 ft. in diameter and 1¼ ins. thick. It lay at an angle of about 70° with the horizontal, with its upper edge inclined toward the hull and its lower edge at a depth of about 50 ft. The anchor and hood had sunk 15 ft. into the mud.

In order to test the possibility of driving without distortion long interlocking steel sheet piles in a cylindrical dam, a test cylinder 9 ft. 5 ins. was driven to a depth of 65 ft. Three ordinary wooden piles were also driven to test the resistance. Samples of the clay when weighed wet gave weights of 114 lbs. per cu. ft. and 124 lbs. per cu. ft. for the soft and tough clays, respectively.

A cyclonic disturbance passed over Havana on Oct. 13, 1910, followed immediately by a second, so that from the 13th to the 18th inclusive, all work was rendered impossible. The diving and boring outfits and barge on which foremast had been placed were swept from their moorings by the winds and beached. The greater part of the diving apparatus was saved. A dredge, offered by the Cuban Government, was sunk and never sufficiently repaired to be available. During that period the derrick boat was in use raising the above dredge and other plant belonging to the Cuban Government. Due to the injury to the plant itself, the last half of October was lost.

On Oct. 27, 1910, a contract was entered into with the Lackawanna Steel Co. for the delivery on the wharf at Casa Blanca of 4,430 tons of Lackawanna interlocking steel sheet piling, ¾-ins. web, 35 lbs. to the sq. ft., in lengths 25, 35, 40 and 50 ft. as ordered, with splice bars, bolts and nuts necessary for assembling into pieces of 75-ft. length, at $33.76 per short ton; 1,154 tons of the same piling assembled into three-way pieces, similarly arranged for splicing, at $38.76 per ton; 108 tons of splice bars, bolts and nuts, bars punched to templet, at $33.76 per ton; steel to be open hearth, containing not more than 0.04 phosphorus, and to have a tensile strength of 65,000 lbs. per sq. in. with a minimum elastic limit of 32,500 lbs. per sq. in.; the interlock was to stand a pull of 9,700 lbs. per lin. in., and in shape the elements were not to vary more than ¼-in. from a right line. Payments were to be made monthly on delivery, with a retain of 5% until completion of order. In addition, a retain of $13.50 per gross ton was reserved. One year after the date of the contract this retain is to be paid, less the value of all piling salvaged and placed in cars at New York City (or other point taking an equivalent freight rate to Buffalo) at a rate of $13.50 per gross ton, unless at the expiration of the said year the contractor grants in writing to the Contracting Officer a further delay in the delivery of the piling. The first 1,000 tons of the piling were to be shipped within ten days after receipt of the order, and the remainder was to be shipped as rapidly as the United States might require. Each pile makes 12¾ ins. of wall; 16 piles make 17 ft. of wall.

During the months of October, November and December, floating plant was collected and altered to adapt it for the work of driving the piles of the cylinders. One 12-in. and one 8-in. centrifugal pump, both direct connected to electric motors and both fitted for pumping sea water under maximum and minimum heads of 65 ft. and 5 ft. respectively, were bought, as were also two, Arnott patent, No. 3, steam pile hammers (weight 3,700 lbs.). In addition one steam hammer was obtained from the T. L. Huston Co. and one was hired from the Cuban Engineering Co. Ordinary pine piles were bought for guides for the cylinder forms and the forms were made. By the end of December the floating plant assembled and in use on the work included two tugs (hired), two launches (hired), one 7-yd. clamshell dredge (loaned by the Republic of Cuba), one hydraulic suction dredge (loaned by the U. S. Eng. Dept.), four pile drivers (three

*Portions of the Report of the Special Board of Engineer officers appointed to supervise the removal of the wreck. From an advance copy of the 1911 Annual Report of the Chief of Engineers.

adapted from plant loaned by Republic of Cuba, and one from a derrick scow loaned by U. S. Navy Dept.), two 100-ton decked scows (bought), one coal barge (loaned by U. S. Navy Dept.), one steam lighter scow (loaned by U. S. Eng. Dept.), three dump scows (loaned by Republic of Cuba) and one 50-ton decked scow, with 15-HP. engine (hired).

DRIVING CYLINDERS.—The first piles were delivered at the wharf at Casa Blanca on Dec. 6. After receipt and storage there, they had to be rehandled to the scows which supplied the drivers. Driving was begun in cylinder S on the same date. During the remainder of the month driving was continued in cylinders C, H, S and F. The process in general was as follows: An ordinary round pile was first driven accurately on the axis of a cylinder. Around this was assembled the circular form, fixed horizontally by the center pile and floating in the water. A bottom piece of steel piling 50 ft. long was then placed against the form and allowed to penetrate into the mud by its weight. The top was usually about 4 ft. above the water surface. A bottom piece of 40-ft. length was then strung through the interlock of the first piece set and suspended on that piece until its 35-ft. top could be placed and bolted fast, when it was allowed to penetrate as far as its weight would admit. This was continued, with bottoms of 50 and 40-ft. length alternately. After a number of piles had been set the driving was begun. The closure of the circle was made by the last 15 to 20 piles which were set and then driven together. The closure was made in the perimeters of the cylinders on the outer face of the cofferdam. Two 3-way piles were set in each cylinder, about 16 piles outside the line of the ellipse passing through the cylinder centers, and one at the middle of the exterior arc. The first two were for the short arcs joining the cylinders, the other for use should emergency require. The piles were driven until their tops were about 2 ft. above the mean low water plane, placing the bottoms at reference -73. After passing reference -65 the rate of penetration under the hammer was slow. The monthly progress in driving was as follows:

	Set Bottoms.	Tops.	Driven.
Dec. 6 to 31, 1910...	520	418	141
Jan. 1 to 31, 1911...	1,053	1,031	1,219
Feb. 1 to 28.....	980	1,099	1,140
Mar. 1 to 31.....	637	642	690
Total.....			3,190

Of these, 2,986 piles were in the cylinders and 204 in the connecting arcs, an average of 149 piles per cylinder and of 10 per arc.

FILLING CYLINDERS.—During the month 3,-000 cu. yds. of material were dredged by the "Barnard" and 5,075 cu. yds. by the "Sagua" (Cuban). The material dredged was placed in cylinders A, B, S and L, and dumped outside cylinder A, where the natural bottom had a greater depth of soft clay. The dredging was done on the extensive bar near the site of the wreck. This bar is composed of irregular beds of clay containing thin strata of coral rock, and is overlaid by a soft mixture of coral sand and clay, of an average thickness of about 8 ft. The soft materials were wasted and only the hard utilized. The depths to which the clay was excavated averaged from about 20 to 40 ft. It was comparatively easy with the "Sagua" to make the requisite selections, but this dredge is poorly constructed and broke down repeatedly under the tough digging. The "Barnard" is a self-propelling hydraulic dredge designed for use on the lower Mississippi River, in which the cutter head of the suction pipe acts by being dragged over the bottom while the dredge is in motion, the pump discharging over the side or at the stern. The dredge was operated over a definite area by lines attached to heavy anchors and passing around the drums of the hoisting engines. Although not designed for work of the character required in Havana, she was able to cut the clay and rock, though with difficulty and at considerable cost. The character of the material may be understood when it is considered that with a discharge which contained not more than 10% of dredged materials, an ordinary dump scow alongside could have a 100 cu. yd. pocket filled in about 15 mins. As the beds of hard material were not regular nor uniformly distributed horizontally and vertically, much soft stuff, unfit for filling was also brought up mingled with the better grades.

The Board was very averse to filling the cylinders by the hydraulic process on account of the great strain on the interlocks of the piles which the liquid mud would produce, and on account of the length of time which would be required for the clay fill to settle and lose some of its extreme plasticity. However the Board found that the "Sagua" was quite unable to dredge the 70,000 cu. yds. required within any reasonable time (its performance averaging about 350 cu. yds. per day, with breakdowns in addition), and that no other suitable dipper dredge could be obtained for less than a prohibitory cost. The excellent qualities shown by the material dredged by the "Barnard," its compactness, quickness of settlement, and the steep slopes held above and below water, convinced the Board that the filling could be made safely by hydraulic dredging, and the Board accepted a liberal offer made by the T. L. Huston Co. to hire their new hydraulic dredge, the "Norman H. Davis," for this purpose. This dredge is of the type which operates at a fixed point with a spiral cutter at the bow driven by an engine. This dredge was brought to the work on March 27, and during the remainder of the month was occupied in clearing and wasting the soft overlying materials from a space about 400 ft. from the cofferdam.

On March 25, cylinder B, which had been practically filled with materials dredged by the "Barnard" and "Sagua," placed in the cylinder by a small clamshell bucket rigged on one of the pile drivers, opened between the third and fourth piles from the three-way pile of the Arc A-B, spreading to a width of 15 ft. The entire fill sank about 3 ft. and a portion spilled out, leaving a slope on the remaining fill of about one on one. A portion of the remaining fill was dredged out and 11 injured and bent piles were withdrawn. It was found that the break had occurred at the closure piles. In this cylinder, one of the first closed, the closure was made with five piles driven with a No. 3 Vulcan hammer. It was noted when driving that the closure was made with difficulty, the last piles driving very hard, and orders were then given to make future closures with not less than 15 piles. When the injured piles were withdrawn it was found that the fingers of the interlock of the closure pile had been straightened, so that when the pressure of the fill was applied, the interlock opened. Since the stresses exerted were much less than the tested strength of the interlock it was evident that the straightening had been done in the driving, with too small a number of piles to allow sufficient total play in the interlock and with too heavy a hammer. The piles showed plainly where the driving out had occurred. The break was repaired by driving 13 new piles in place of those bent and removed, of which 12 were the ordinary steel piles and one was wedge-shaped, 12½ ins. wide at bottom and 35 ins. wide at top. The cylinder was refilled.

The cylinders as driven were not all in contact at the theoretical points of tangency. To hold the fill in the sectors within the joining arcs, one to three palm piles 45 ft. long were driven between each pair of cylinders at a point slightly nearer the interior of the cofferdam than the theoretical point of tangency. To increase the holding power, a riprap base was made inside, and their tops were fastened to the adjacent cylinders with wire rope.

In order to obtain some record of the internal pressures, 11 pressure gages were placed in the cylinders; 4 in cylinder H, at depths of 20, 30, 40 and 50 ft. below the plane of mean low water; 4 in cylinder F, of which 2 were on a wooden pile, alongside of pile No. 53, at elevations of -30 and -40, 2 on a wooden pile alongside of piles Nos 133 and 134, at elevations of -30 and -40; and 3 in cylinder G attached to the drain box in the axis at elevations of -20, -30 and -40 ft. One pressure gage was placed on a wooden pile outside cylinder F, alongside piles Nos. 133 and 134 at an elevation of -40.

The filling of the cylinders was continued until May 11, when the "Norman H. Davis" was discharged. She had dredged in all 57,048 cu. yds. filling all cylinders and arcs excepting A and B. The overflow from the fill caused a further deposit outside and inside the cylinders. The "Sagua" dredged 750 cu. yds. of which 430 cu. yds. were of good materials; 1,086 cu. yds. of stone were also placed, partly inside of cylinders N and O, and partly around the palm piles and within the sectors. A drain box, of 2 × 12-in. planks, suitably braced and having an outside horizontal cross section of 3 × 3 ft., was placed in each of cylinders L, M, N, O, Q, F, G, H, J and K. The drain boxes are located on the axis and extend to a depth of 50 ft. Sluiceways for flooding the cofferdam when necessary were placed across the tops of cylinders B and C. That in B has a section of 3 × 3 ft. and that of C 3 × 7 ft. They are closed by sliding wooden gates. The steel piles having been driven to within 2 ft. of the mean low water plane, the shells of the cylinders were built up to an elevation of +4 ft with wooden plank set vertically in the fill.

On May 8, after the fill within had reached an elevation of +3 ft., and while pumping was in progress, cylinder N broke open. The opening was formed at the 13th pile from the three-way pile of the arc N-O, being about 30 ft. wide at top. The adjacent piles were bent down until their tops were submerged about 7 ft. A portion of the fill next to the opening flowed out, but the greater part remained in the cylinder, showing slopes of about 1 to 1. No change occurred in the sector N-M near the break. Thirty-five piles were withdrawn—a task of great difficulty, since the upper parts were badly bent, the portions below the mud level not having been moved. This last was the more remarkable since the site of cylinder N had been dredged to a depth of about 50 ft. to clear away the wreckage hereinbefore reported as found there, and refilled with new material to a depth of about 30 ft. A new closure was made with 43 piles, making a total of 3,200 in the dam. The cylinder was refilled by means of a clamshell dredge, the work being completed so as to permit the unwatering of the cofferdam to begin June 5. On removing the piling and examining into the cause of the breakage, it was found that in driving one of the piles had become twisted and had left the interlock of the adjacent pile at its splice, and that this pile, which had a 40-ft. top, must have been defective, for under the stresses caused by the fill it tore through its web at about its middle line from bottom to top.

The two pumps previously mentioned had been placed on floats within the cofferdam. An electric cable for light and power had been laid between a small transformer house built on piles just outside of the cofferdam and the Luz Wharf at Havana.

PUMPING DRY.—On April 25 the S. S. "Havana" of the Ward Line, in going to her moorings at the Luz Wharf, dragged the cable, which broke at the transformer house and burned out. A new cable had to be laid. This work was completed by the midle of May. On June 5, unwatering was started, with the 8-in. pump and the level of water within the cofferdam was reduced to -5. On June 15 and 16 the water was lowered to -10, and on June 20 to -15.* A slight movement inward was observed on the part of the cylinders and on the 22d, the water level was raised to -12 and the cylinders were kept under a head of between 10 and 12 ft. during the remainder of the month. The leakage through the cylinders was very slight, raising the level of the water inside about ½ ft. in 6 hours. Investigation having shown that the clay filling was yet very plastic, the drainage of the cylinders and the grading of the top of the fill by removing the clay from the inner perimeters of the cylinders to the outer, was begun and carried on vigorously. Stone in amount 8,000 cu. yds. was ordered and as delivered was placed against the palm piles in the inner sectors between the cylinders. The cylinders are drained by placing steam siphons in the drain boxes and in 6-in. and 8-in. perforated pipes sunk into the cylinders not provided with larger drains. Leakz of some magnitude developed in cylinder F, and an examination by the diver showed that many of the bolts holding the fishplates which connect the piling of cylinder F had been jogged out in the driving and that water was entering through the bolt holes. These were plugged as far as possible and a deposit of clay was placed outside the cylinder and banked up to a height of about -23, reducing the leak to insignificant proportions. In the latter work the bolts had been upset before driving, but several of the cylinders had been driven before this was done. An examination was made by the diver of these cylinders, and such bolt holes as were found empty were plugged. By the close of the month the dam was fairly tight and the clay filling was rapidly consolidating, clay from the inside of the cylinder tops being piled up on the outside as the fill settles.

EXAMINATION OF WRECK.—The main deck of the "Maine" as far as it remained in place, together with the Captain's cabin in the superstructure on that deck, were exposed when the water reached -12. The deck and floor of the cabin were found to be covered to a depth of 3 to 5 ft. with a deposit of mud, oyster shells and a coraline formation. This was cleared away,

*The depth of unwatering reached -20 ft. by July 20 and -22 by July 26; after which further material to be removed within and around the wreck within the cofferdam was mainly 50 ft. sticky mud.

and all articles of equipment, furniture and armament found were turned over to a representative of the Navy Department and by him placed on the naval collier "Leonidas" which had been sent to Havana for that purpose. The human remains discovered, up to June 30, consisted of two arm bones, the bones of a foot and two rib bones. The metal of the "Maine" exposed was found to be badly corroded. In a box by the after turret were found a quantity of web belts, with bayonets in their scabbards attached and with cartridges in their pockets. Electrical action had apparently set up between the steel of the bayonets and the cartridge cases, which had rotted the steel completely and deposited a portion of it in the form of an iron oxide on and around the cartridges, making of the belts, scabbards and cartridges a solid mass. Similarly, an officer's sword had been eaten away completely at the junction of the blade and the hilt. Some articles, such as the electric light fixtures, rubber bands and rubber mats, were found in a remarkable state of preservation. Textile fabrics had almost entirely disappeared. Arrangements are being made for cutting up the steel of the destroyed portion of the wreck into manageable pieces with an oxy-acetylene blow pipe plant, and its removal to barges by derricks.

Out of the $650,000 appropriated up to June 30 there had been expended or pledged the sum of $462,476.32, leaving a balance of $187,523.68, which will be sufficient to carry on the work until December, but will probably be insufficient to complete all the work.

CONDITION OF WRECK.—From the best information now available, it appears that the after portion of the vessel, from the stern to about frame 54, a length of about 122 ft., measured along the berth deck, has been damaged but little by the explosion. Forward of frame 54, for a length of 51 ft. to frame 41, the portion of the superstructure over the after boiler room is in place, but is shattered and twisted. On the starboard side the side of the ship seems to be intact nearly to frame 41. On the port side the main deck has been torn loose aft of frame 41, and the ship's side blown out to about 15 ft. from frame 54. Forward of frame 41 the ship seems to have been entirely destroyed. For about 60 ft. little or nothing is seen and it is probable that the ship may have been cut through. Further forward is a twisted mass of steel which is out of line with the after portion of the wreck and retains no semblance to a ship.

The exposure of the wreck already made has demonstrated clearly the impracticability of raising the wreck bodily from the mud, and the necessity of adopting the cofferdam method. The unprecedented character of the work and the uncertainty attending the advent of atmospheric disturbances have made anything like a reliable estimate of cost impossible. The conditions have been more adverse than had been anticipated and the cost has proved correspondingly greater.

The cofferdam is now practically completed. It is unusually tight and appears to be stable. With the completion of the stone toe originally provided for, little will remain to be done to it as far as can be foreseen, though a recurrence of conditions similar to the cyclonic disturbances of last October may cause damage and delay.

The removal to Arlington Cemetery of the remains of the dead found, and the removal of the main mast of the ship and its erection in Arlington Cemetery as required by Congress, are simple matters. The problems now confronting the Board are the removal of the wreckage from its bed of mud (which has been increased in depth about 10 ft. by the work incident to the construction of the cofferdam); the disposal of the wreckage and the restoration of the site to its original condition. Some of the parts of the wreckage, such as armor plates, turret top, etc., weigh from 15 to 25 tons each. The 10-in. guns weigh about 40 tons each. This work presents difficulties, but the Board believes that the greatest uncertainties in the cost of the work are those connected with the construction and unwatering of the cofferdam.

Making reasonable allowance for the unknown contingencies, the Board now estimates that the aggregate cost will not exceed the appropriations already made by more than $250,000.

As noted in our issue of last week, the President sent a special message to Congress the day before it adjourned last month, asking for this additional $250,000. There was not then time to pass this appropriation.

The Last Broad-Gage Railway in North America, the Carillon & Grenville Ry., Canada.

The early railways of the United States and Canada had gages of various widths, since in those days there was little thought of their ultimately being extended and connected to form through lines and complete railway systems. In the United States, the last broad-gage lines (with gages wider than the present standard of 4 ft. 8½ ins.) have been converted to standard gage for many years, and only a few narrow-gage lines remain. In Canada, a gage of 5 ft. 6 ins. was adopted by several of the early railways, but all have been converted to standard gage, with the exception of one short isolated line. This is the Carillon & Grenville Ry., having a length of 13 miles. As the line has been purchased recently by the Canadian Northern Ry., which will rebuild it to standard gage and make it a link in its system, some mention of it at this time will be of interest. The railway is notable not only for its gage, but for its 60-year old locomotives, and for the fact that it has retained its construction, equipment and corporate existence unchanged for over 50 years.

The Carillon & Grenville Ry. extends between the two towns of Carillon and Grenville, on the east bank of the Ottawa River, in Quebec. Between these points there are rapids in the river, and for some years the line has been owned by the Ottawa River Navigation Co., and operated only in connection with steamer service above and below.

It was built under an act passed by the Canadian government in 1856 for the construction of a line between Quebec and Lake Huron by five companies which were constituted a body corporate under the name of the Lake Huron, Ottawa & Quebec Junction Ry. Co. The act authorized the Montreal & Bytown Ry. Co. and the Vaudreuil Ry. Co. jointly to build a line from opposite Grenville to the city of Ottawa, the former company to build the half nearest to Grenville.

It is of interest to note that this charter of 1856 opened with the following statement regarding the development of Canada:

> It is of the utmost importance to the general interests of this Province, that a main line of railway communication should be opened from Lake Huron to the Ottawa and thence to Quebec in the most direct line; and the opening of such line from Arnprior or some place between Arnprior and Pembroke, on the River Ottawa, to such point on Lake Huron as may be found best adapted for the purpose, would secure for the said main line so large a proportion of the travel and traffic of the Great West as to ensure the success of the remainder of the line from the River Ottawa to Quebec, while it would also open for settlement a most valuable tract of country now unimproved and waste.

The act set apart for the railway from the Ottawa River to Lake Huron, 4,000,000 acres of land; this was to be granted in proportion to the length of line built, when not less than 25 miles had been completed "in a good and permanent manner, equal at least to that in which the Great Western Railway is made, and with stations, rolling stock and other appurtenances sufficient for the proper working of the railway." The grant was conditional upon the report "of some skilled engineer whom the governor shall appoint for the purpose."

The line from Grenville to Carillon is all that was ever built under the charter to the Montreal & Bytown Ry., and in 1859 an act was passed authorizing certain persons "interested in the purchase at sheriff's sale" of this part of the line, to form the Carillon & Grenville Ry. Co., and complete the line to landing places on the river at these points; the capital stock was set at $200,000. In 1860 another act was passed, providing for extensions from Carillon to connect with the Grand Trunk Ry. and other railways between Quebec and Montreal, and providing also for an extension to Ottawa in the event of certain other companies failing to build a line between Montreal and Ottawa. The capital stock was increased to $1,800,000. The charter granted under this act was unique in that it set no limit as to the time within which the extensions should be made. In 1861, an act was passed permitting an extension to Lachine to connect with the Montreal & Champlain Ry.

Nothing came of any of these extension projects, and the line has remained until now an isolated piece of railway. It was purchased by the Ottawa River Navigation Co. in 1883, and has since been operated only during the summer season and in connection with the steamer service, serving as a portage line past the rapids. In 1899 it was expected that the line would be purchased by the Great Northern Ry. of Quebec, but this railway was itself absorbed by the Canadian Northern Ry., which has now purchased the old Carillon & Grenville Ry.

The gage of 5 ft. 6 ins. was adopted because several of the early Canadian lines were of that gage. The track is laid with 65-lb. iron rails of English manufacture, and of the bridge (or inverted U) type of section. The equipment in 1899 comprised 3 locomotives, 3 passenger cars, 1 second-class car, 2 baggage cars and 2 flat cars. At the present time it has but two locomotives. The oldest of these, named the "Carillon," is shown in the accompanying cut, and is said to have been built in 1849; other reports put its date a few years later. In any case, these old locomotives are probably the oldest in existence that are still in active service. One of the engines was bought from the Grand Trunk Ry. about 27 years ago, and is one of 50 engines built for this line during 1854-1858 at the Canada Works, Birkenhead (England), to the order of Peto, Betts & Jackson, the contractors for the construction of the Grand Trunk Ry. The cylinders are outside the frames and inclined toward the driving axle; they are 16 x 20 ins., but others of the engines had the diameter 15 and 17 ins. (with 20 ins. stroke). The engines with the smallest cylinders had a single pair of 6 ft. driving wheels, but all the others had four 5-ft. driving wheels. As originally built, each engine had a single leading axle, but these were replaced gradually by four-wheel trucks. The boiler is of iron, with copper firebox, and 170 brass tubes 1⅞ ins. diameter. The steam pressure is 110 lbs. Wood is used for fuel. The weight of the engine is about 60,000 lbs. This Carillon & Grenville Ry. engine is said to be the last of the lot of fifty noted above.

The Locomotive "Carillon" of the Grenville & Carillon Ry. Canada, (5 Ft. 6 Ins. Gage). Built in England About 1850.

It is to be hoped that this engine and a stretch of the original track will be secured by some museum or other institution in Canada as interesting relics of early railway practice.

The English Census of 1911 showed a total population, on April 2, of 45,216,665. This total was distributed as follows: England, 34,043,076; Wales, 2,032,193; Scotland, 4,759,445; Ireland, 4,381,951. During the decade the population of England and Wales increased 10.9%, which was a slightly less rate of increase than for the two previous decades. The population of Ireland continued to decrease, but at a less rate than during any of the previous five decades. The urban population of England and Wales was 78.1% of the total in 1911 as against 77% in 1901, but the dividing line between urban and rural population is not stated in the information before us.

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Why Not Advertise Private Contracts as Well as Public Contracts?

We publish in this issue a paper in which the principles are laid down which should govern the engineer in the letting of public contracts. This article seems to us to make opportune the question which we have put at the head of this article. Why not advertise for bids on private contracts as well as on public contracts?

Let us say at once that we do not mean by this question to suggest that all contracts let by private concerns or even any large proportion of them ought to be publicly advertised. The disadvantages under which public works have often to be conducted on account of the rigid requirement of laws compelling public advertising and letting of contracts are fully appreciated.

We do believe, however, that there are many contracts let by private firms and particularly by public-service corporations on which money could be saved and better work could be secured were the works publicly advertised before letting. Further than this, such public advertising and letting would tend to prevent graft and fraud, which now flourish inside many a private corporation quite as luxuriantly as in the shadow of City Halls and State Capitols.

The business of many of the so-called corporations is really not private business at all. A railway or a water-works system or an electric lighting plant, a bank or an insurance company — none of these are the property of their owners to do with just as they please. Much less have the managers a right to manage according to their own sweet will. The managers of a railway company are trustees for the stockholders on the one hand and for the public on the other. Where they manipulate contracts for their own benefit they are defrauding both the stockholders and the public.

We do not by any means go so far as to say that such public corporations should be compelled by law to advertise their contracts and let them openly. We do say that an honest Board of Directors of a concern can put up some effective bars against graft and fraud by ordering that all important contracts given out by their firm shall be advertised and let publicly.

One recalls the sort of contracts unearthed when the affairs of the great life insurance companies were laid open to the public a few years ago, the recently exposed car repairing contracts on one of the oldest and most conservative of Western railways, the way in which unknown contracting firms without previous experience or financial standing have suddenly appeared as the successful bidders for large contracts.

We believe public advertising and letting of contracts is needed as much to protect stockholders from robbery as it is to protect taxpayers.

Another Proposed Compromise in the Passaic Valley-New York Harbor Sewage-Disposal Litigation.

A battle royal of experts against experts that might have made the St. Louis-Chicago lawsuit over the Chicago Drainage Canal seem schoolboy play bids fair to be averted by a compromise in the injunction suit to prevent the execution of the Passaic Valley trunk sewer project. The suit was originally brought by the State of New York. The United States afterwards joined, but before material progress was made a compromise was effected with the United States (see Eng. News, May 12, 1910, for "Stipulations" and editorial comment thereon) by the terms of which the Passaic Commission agreed to do more in the way of treatment than it had proposed to do theretofore.

It was generally understood at the time of the compromise that the State of New York would also withdraw its suit; but it did not do so. This may or may not have been due to the activities of the Metropolitan Sewerage Commission of New York, which advised Mayor Gaynor that the compromise and "Stipulations" did not protect the interests of New York City and urged that the city seek intervention in the state suit and failing that bring a suit of its own to prevent the carrying out of the Passaic Valley sewage-disposal plans (see Eng. News, June 9, 1910, for editorial discussion of this matter).

In December, 1910, it was reported that the city of New York was denied intervention in the State suit (Eng. News, Dec. 22, 1910, p. 701). Nevertheless, the city seems to have been involved in the reopening of the State suit, when the taking of testimony was begun early in the present month, only to be suddenly interrupted by adjournment for the purpose of considering a possible compromise.

We have already recorded our belief that litigation on this subject, after the compromise with the United States, would be foolishness (June 9, 1910), since the New Jersey authorities had agreed to do all, if not more, than could be reasonably expected to forestall pollution of New York Harbor by their proposed trunk sewer, while the responsible New York authorities had done practically nothing to abate any nuisances arising or likely to arise from the discharge of immense volumes of their own untreated sewage at the handiest point of outlet which could be found.

Of what benefit to anybody, save in the way of fees, would it be to pile up scores of thousands of pages of testimony in this case? testimony in which a few jewels of scientific fact would be buried in an immense mass of conjecture—elicited from "expert witnesses," it is true, but under the leadership of highly skilled partisan lawyers, each side intent on winning the case and with little concern for science and truth.

We see little more likelihood that this Passaic Valley case would settle any fundamental questions relating to the pollution of interstate waters than did the Chicago Drainage Canal case. After considering all the expert testimony and all the learning and eloquence exhibited by the lawyers' briefs and arguments the judges would probably declare a tie between the engineers and chemists and bacteriologists and then side step to a decision that New York, like St. Louis, had come into court with such foul hands as to make it appear that municipal cleansing should begin at home.

Cleansing rather than health, it is important to note, is almost the sole question at issue in the present case, whereas in the St. Louis-Chicago suit there were at least good talking points as to menace to health.

We declare that the present case is one of cleansing rather than health with all the more confidence because a careful examination of the ponderous report issued by the Metropolitan Sewerage Commission of New York shows that after all its years of search it has been unable to find any far-reaching and well-proven relationship between sewage disposal by dilution in immense volumes of deep salt water on the one hand and the public health on the other.

Possibly New York City will make a temporary gain by having pursued the litigation after the United States compromise, provided it follows suit by agreeing to a further compromise. Should New York be too insistent upon terms, it may be expected that efforts at compromise will fail. It will be well for New York City to remember that any compromise exactions which it secures may serve as a standard for it to comply with in the establishment of immense sewage-purification works to care for its own wastes at an early date. As we have pointed out more than once, the whole metropolitan district, New York and New Jersey alike, has other and more pressing needs than those associated with any material degree of sewage purification.

A Decision Against Compelling Water Consumers to Pay For the Installation of Meters.

One of the greatest obstacles to the introduction of water meters is the requirement that the cost of installation and maintenance shall be met by the water consumer. This obstacle is all the greater when the water service is furnished by a private company. It is therefore particularly interesting to note that the Wisconsin Railroad Commission (public service commission) has ruled, in the case of the Janesville Water Co., that the company must buy, install and maintain meters, and also supply and install that portion of the service pipe which extends from the street main to the curb line, and include both as a part of its plant. At the same time, the Commission rules, as it has done once before in the case of another city, that the municipality should pay for water for fire protection and other public purposes. Both these rulings will meet the approval of water-works men throughout the country, and are in line with sound public policy.

Control of Domestic Water-Supply Fittings as a Means of Water-Waste Prevention.

The low per capita water consumption of British cities is due in no small measure to the rigid system of inspection of house fittings which is carried on by municipal authorities in Great Britain. Sole reliance is by no means placed on the inspection. The water authorities prescribe what kind of fittings shall be used and permit no fittings to be installed which do not come within the regulations. In fact, they even go further in many cases and require that the fittings must be tested by the water department and be given its stamp of approval.

Some of those who are trying to aid in the much-needed campaign for water-waste reduction are advocating the insertion in the new charter, which is now pending before the legislature, of a clause providing that the Commissioner of Water Supply, subject to the approval of the Board of Estimate, shall have the power to establish "standards of size, weight and quality of all new fittings which shall hereafter be used for the distribution of water in or outside of buildings."

Power of this kind should certainly be given to the city authorities of New York, particularly if it is to remain a practically unmetered city.

As we have often stated, the water meter is the best inspector because it is always "on the job." Without water meters, inspectors may come and inspectors may go, but waste goes on forever. With meters, there may, of course be some waste, but it is greatly reduced and the person responsible for it pays the bill. Where there is no water meter, any amount of inspection which is practicable will not prevent large aggregate volumes of leakage from imperfect fixtures, making it doubly important to have control over fittings.

Concerning the Work of Raising the Maine: An Unwise Expenditure of Public Funds.

We print elsewhere in this issue the report of the Board of Engineer Officers in charge of the work of "Raising the Maine," or, to give the work its official title: "Removal of Wreck of Battleship Maine." Those of our readers who are accustomed to peruse the official reports of the Army Engineers (we wonder how many such readers there are!) will understand that these documents are not long on sentiment.

For sentiment one must go elsewhere; and we have found it—by the gallon—in a story in "Collier's" of Sept. 9, headed in big letters:

"THE MAINE—REMEMBERED."

The story sets forth how away back in 1905 a "salvage company" proposed to raise the wreck of the "Maine" and make money out of the job. How were they going to make money? By charging admission to visitors, either in Havana Harbor after the wreck was laid dry, or else by floating the ship "on her own or a false bottom" and exhibiting her in the principal ports of the United States. "In the remote event that it is utterly impossible to float the wreck it will still be a paying investment, for after exhibiting the wreck at Havana it will be taken apart piece by piece, to be manufactured into mementos."

All this the story relates and relates correctly. The circular wooden cofferdam which the company planned to build around the wreck in order to lay it dry was described and illustrated in Engineering News of Dec. 8, 1904. In fact an earlier proposal for a wooden cofferdam around the vessel was made in this journal by Mr. G. W. Pearsons in our issue of March 10, 1898. It is interesting to note that the prospectus of the salvage company set forth that "it will take from forty to sixty days to complete the cofferdam and to pump it out."

The "Collier's" story then tells how one of the stock-selling prospectuses of this company happened to fall into the hands of an old soldier, Captain Alfred King of Arlington, N. J. Captain King at once began writing letters to the newspapers protesting against such commercial exploitation of the wreck and the story writer reports the result as follows:

> To the salvage company this publicity was more than a vexation. Two months passed and found them still hovering over the wreck but afraid to swoop down to pick the bones.
> King simply kept on writing.
> A few more months of hesitation and the salvage company closed its offices and evaporated.

There is one thing that is better than sentiment, or attempts to produce sentiment by picturesque narrative and that is truth. The real reason why the company referred to "evaporated" was because the suckers, whom it sought to entice by its fine prospectus and its glittering pictures of the enormous profits to be made by an investment in its stock, did not suck.

Only a beggarly $20,000 or so was received by the company as a result of its stock-selling campaign, hence the promoters of the scheme were perforce obliged to drop it.

It might perhaps be claimed that the stock did not sell because of the old soldier's newspaper letters; but one does not need to go so far afield to find a reason. The investing public simply was unconvinced by the glittering promise of huge profits held out by the promoters. Captain King did not kill the scheme. It died a natural death.

The story then continues—and from this point onward we have no reason to doubt its accuracy—to tell how Captain King then proceeded in his campaign of publicity with the object of persuading the U. S. Government to undertake the work of raising the wreck. The promoters of the salvage company had indicated how cheaply and easily it might be done. He had no reason to doubt that part of their claims. And according to the story writer, King's appeals to public sentiment were so effectual as to be actually responsible for the passage by Congress, in 1910, of the act ordering work on the "Maine" wreck to be undertaken.

And so, as a result of this stirring up of patriotic sentiment by this well-meaning old soldier, the United States has spent half a million dollars already, and will spend the better part of another half a million dollars at least before it finishes the job, to pull the pieces of an old battleship out of the mud of Havana Harbor.

The writer in "Collier's" carries the idea that the work is a particularly patriotic job, redounding to the honor of the country. If that were indeed true, we would raise not the slightest objection to the expenditure of a million or two million or whatever the work might cost. To stimulate true patriotic zeal in a people is well worth a nation's expenditure. But we have never been able to see any such results from the work on the wreck of the "Maine."

So far as recovering the remains of the men who lost their lives in the wreck is concerned, the bones of the men who died in that wreck are just as decently and honorably buried there, where they met death in the line of duty, as they could be anywhere.

As for there being any particular glory to the nation in recovering any part of the rusted scrap which forms the wreck of the old vessel, it has never been apparent to us. The idea once prevalent that the wreck was in such condition that it could be raised and floated intact probably had strong influence in inducing Congress to order the work in the first place; but it is now known to be utterly fallacious. It would be possible to cut off, bulkhead and float the after third of the hull; but after it was floated it would be a perfectly useless piece of scrap, and the only thing to do would be to tow it into deep water and let it sink.

It will be possible by spending money like water and incurring risk to more lives than those lost in the "Maine" explosion, to dig out the rest of the wreck from the semi-liquid mud in which it lies buried, and that, too, can be dumped in deep water or sold as scrap. We discern no "glory" in the accomplishment of the task in either case.

It seems to us that this recital of facts is worth a little thought in these days when the pendulum is swinging in favor of submitting all public matters to the sway of popular sentiment and popular vote. Popular sentiment—or the sentiment of that small part of the public which alone makes itself heard—demands that a million dollars be spent to recover the shattered remnants of a vessel's hull; but knows nothing of the dozens or hundreds of other ways in which that money could have been spent with vastly greater return in the way of public benefit.

In view of these facts the public ought to clearly understand that neither the engineering profession nor the Army Engineers in charge of the work upon the wreck, have any responsibility for the original undertaking of the work.

The Army Engineers have merely obeyed orders. As the report printed elsewhere in this issue shows, they simply endeavored to find what Congress wished them to accomplish when it ordered the work undertaken and then went ahead to carry it out to the best of their ability. They deserve credit for their plucky perseverance in carrying the work forward in the face of great difficulties. Those who compare the official plans for the work published in our issue of Oct. 20 last with the report in this issue can appreciate how pregnant with meaning is the sentence in the present report: "The conditions have proved more adverse than had been anticipated and the cost has proved correspondingly greater."

One feature, however, has proved more favorable than there was reason to expect. The clay with which the cofferdam cylinders are filled has been less liquid and has exerted less bursting pressure on the cylinders than might easily have happened. Notwithstanding this [illegible] of the cylinders have burst open, and even with the support afforded by the mounds of rip-rap inside the dam, it appears that the structure is withstanding about as much pressure as it is safe to place upon it. The difficulties in the way of going deeper into the mud to haul out the lower part of the wreck have already been set forth in these columns; but so long as the Government authorities continue to furnish money and order the work to proceed, the engineers will doubtless continue to find ways to meet difficulties as they arise.

It is "their's not to reason why;" but they cannot be blamed if they sometimes wonder why.

LETTERS TO THE EDITOR.

The Climate of the Northeast Coast of England and Scotland.

Sir: From your issue of Dec. 22, 1910, p. 691, I cut out a paragraph which I have kept with a view to refuting the statements, which give a greatly exaggerated idea of the severity of the climate of the northeast coast of England. I quote the paragraph in full as follows:

> The northeast coast of England and Scotland is one of the bleakest and most unprotected in the world. In a far northern latitude, removed from the warming currents that temper the climate on the opposite side of the island, with a broad, free sweep of polar sea down to the very shores, probably no more undesirable place could be picked out on the navigable waters of the globe wherein to locate harbors.

This statement is made without knowledge of the effects of the Gulf Stream generally, the usual circular movement in the Atlantic in the winter and the extent to which the northeast coast shares in the effects of favorable anticyclones in northwestern Europe, and in the sweep of southwestern winds across the British Isles. The tides have also an influence.

The "far northern latitude" has very little to do with it; we must study isotherms, not parallels of latitude. New York, with its sweltering summers and bitter winters is a far "more undesirable" place to locate almost anything. If we study the actual data we find that the northeast coast, though colder than the southeast coast or South Wales, is not much colder. I have compared it, for the worst period of the year, January, February, March, with Sandwich on the southeast coast and Haverford-west in South Wales, taking the climatological station of Scarborough, but knocking off 2° F. from each recorded temperature, which, from a study of temperatures at neighboring places, is found to be a full allowance for the somewhat warmer aspect of the station itself. The results, taking the figures for 1909 and 1910 are approximately as follows:

In 1909 the mean temperature for the northeast coast was about 3° F. colder than the southeast coast (Sandwich) and 4½° colder than South Wales (Haverford-west). The mean minimum was the same as the southeast coast, and 1° colder than the southwest coast (South Wales). The mean maximum was 1½° colder than that of the southeast coast, and 3° colder than South Wales. The extreme minimum was several degrees above that at either. The days of snow only (i. e. not "rain, snow, or sleet") were not more than at the southwest, and five less than at the southeast coast. The number of "gales" was the mean of those at the other two stations. Winds from E., N. E., and N. were also about the mean of the other figures. Winds from W., S. W. and S. were 81 (number of observations) against 44 at South Wales and 58 at Sandwich.

In 1910 the mean temperature was 38° against 39° at Sandwich and 43½° in South Wales. The mean minimum on the northeast coast was just above that on the southeast and 4½° lower than in South Wales. The mean maximum was 45° against 43½° and 48½°. The extreme minimum was several degrees warmer than either of the others. The days of snow only were 9 against 3 and 7. Winds, E., N. E., and N. were 22 against 15 and 41, from W., S. W. and S., 86 against 76 and 85.

These figures speak for themselves, and most of the inland stations would show much less differences than those between the northeast

coast and South Wales, which is a promontory with deep water on both sides.

The northeast coast is very bleak when the N. N. E. current holds in the spring, but this is usually towards the end of March or in April, and nearly the whole of the country shares in this current, the mean temperature being not so very low after all, but the dryness extreme. This current occurs when the spring has well set in, and usually after some warm gales and rain. The east coast of the United States gets a cold current in the winter when we are on the warm side of the great Atlantic cyclonic movement.

This letter is written as a grateful acknowledgment of the great pains which the editors of Engineering News take to place before their readers the most reliable data and information which can be obtained, and on matters much more important.

"Anglo-Norman."

Dorking, England, Aug. 29, 1911.

[There are some things that no real man can fail to resent; chief among them is criticism of the climate of that particular spot where he makes his home. We should have known better. By the same token, we would not call New York winters "bitter."—Ed.]

Notes and Queries.

In connection with the editorial note in our issue of Aug. 31, p. 295, on the duty of water in irrigation, our attention has been called to the discussion of Paper No. 1187, Transactions of the American Society of Civil Engineers, in which Mr. Clemens Herschel, M. Am. Soc. C. E., mentioned experiments made by him on arid lands in the West, by which he was convinced that greater crops per acre could be raised if only half as much water per acre were used in irrigation. Realizing the impracticability of enforcing laws limiting the use of water by watchmen, he has worked up a design of a recording meter for irrigation canals which will keep a record of the amount of water used. This design is reproduced on p. 346 of the Transactions of the American Society of Civil Engineers for March, 1911.

The damage done by an explosion of dynamite Aug. 11 at the mouth of shaft No. 6 of the New York Aqueduct, near Cornwall-on-Hudson, was much exaggerated in the newspaper reports from which was taken the brief item in our issue of Aug. 17, according to information received from the Mason & Hanger Co., the contractor in charge of the work. The explosion, we are informed, involved only about 400 or 500 lbs. of dynamite and caused no loss of life with only insignificant damage to property. The Mason & Hanger Co. is now at work on contract No. 63 of the aqueduct, with headquarters in Van Cortlandt Park, New York City.

U. S. Census Report on the Manufacture of Electrical Apparatus in 1909.

The U. S. Census Bureau has made a preliminary report on the manufacture of electrical machinery and apparatus for the year ending Dec. 31, 1909. In a few cases the figures included are from establishments where the year ended on a different date.

The total value of machinery and apparatus manufactured rose, in ten years, from $105,832,000 to $243,967,000, or 130%. Large quantities of supplies for electrical uses are manufactured in establishments not identified with the industry, and accurate information in regard to these has not been secured. On this account the figures are under the true value for all the electrical machinery manufactured in 1909. The value of products given represents their selling price at the plants and has no necessary relation to the sales for the year.

The details of this growth are obscured in some important cases by the policy of the Census Bureau in not publishing figures where the particular branch of business is largely in the hands of one or a few companies, lest the operations of the concerns should be disclosed. On this account certain important information cannot be secured on electric motors, arc lamps, metallic-filament and graphitic-filament lamps.

Dynamos, motor generators and similar machines constitute the most important group. The number increased from 10,527 to 16,791 in ten years, or 59%. The value rose from $10,473,000 to $13,081,000. As larger generators were manufactured in 1909 than previously, the average value was greater, but the cost per unit capacity was lower. The average capacity per machine increased from 55 KW. to 84 KW. in ten years. The value of converters, boosters, etc., rose from $380,000 to $3,155,000 in ten years, or 730%. The five-year figures of 1904-1909 for generating machinery are small in proportion and the explanation is not obvious.

The total value of motors of all kinds, including supplies and parts, increased 64% for the decade, or from $19,505,000 to $32,087,000. The distribution of the gain in the sub-classes of stationary-power, automobile, fan, railway, etc., is shown in the accompanying table. While many heavy motors were manufactured, the great increase in the number of small machines has reduced the average capacity of machine, the average horse-power ranging from 14.5 to 8.5 and 6.7 for the years 1899, 1904 and 1909. While there has been greater activity in the manufacture of automobile motors, the increase has still not kept pace with that for other classes of apparatus. The capacity and value have, however, increased. Motors for electric railways have been massed with those for elevators, etc. The decade figures show only a small increase—not at all in correspondence with the growth of electric railways as disclosed in the U. S. Census reports for 1902-1907. In that five-year period, which unfortunately does not quite correspond to the manufacturing-census period of 1904-1909, the miles of street-railway track increased from 21,908 to 34,060, the cost of construction from $2,167,634,074 to $3,637,668,708, the cars in use from 66,784 to 83,641, the capacity of power plants from 134,921 HP. to 2,476,479, and the gross income from $250,504,627 to $429,749,254. The only statement made concerning the manufacture of railway motors is that "the manufacture of railway motors has shown a considerable increase."

The figures for storage and primary batteries comprise figures for various elements which are not always sold combined into units. Many parts and supplies are manufactured outside the electrical industry and the statistics quoted cannot convey an adequate idea of the magnitude of this branch of the industry.

The number of arc lamps increased from 1899 to 1904 and decreased from then to 1909. The decrease may be accounted for by the introduction of large incandescent lamps of improved types and a feeling of uncertainty regarding the type of arc eventually most desirable. The total number of incandescent lamps manufactured has not been obtained accurately on account of the immense amount of varieties. Neither has a desirable separation been made to show the development of common-carbon, graphitized and metal-filament types.

The value of lighting fixtures of all kinds fell from $3,751,000 in 1899 to $3,295,000 in 1904, but rose to $6,128,000 in 1909. This does not include combination gas and electric fixtures manufactured by concerns not identified with the electric industry primarily, and their value is not included. It is stated, however, that according to the census of 1909, the value of these combination fixtures appears to be $12,884,000 additional.

Figures for telegraph instruments include apparatus of all kinds for the transmission of intelligence except the telephone. The figures for telephone apparatus include complete sets and parts of instruments, switchboards, supplies, etc. The returns show a slight decrease during the last five-year period, which is puzzling in view of the census figures of the telephone industry for 1902-1907. In that period the number of telephones in use increased from 2,315,297 to 6,118,578 and the total capitalization of companies rose from $348,031,058 to $814,616,004.

THE PRODUCTION OF ELECTRICAL MACHINERY, ETC., IN 1909, 1904 AND 1899; U. S. CENSUS REPORT.

	1909.	1904.	1899.
Number of establishments	[1]1,255	[1]912	[1]581
Total value of products	$243,967,000	$159,551,000	$105,832,000
Dynamos:			
Number	16,791	15,080	10,527
Total kilowatts	1,405,951	996,182	578,124
Value	$13,081,000	$11,084,000	$10,473,000
Dynamotors, motor generators, boosters, rotary converters and double-current generators	$3,155,000	$1,740,000	$380,000
Transformers for light and power	$8,801,000	$4,469,000	$2,963,000
Switchboards, panel boards, cut-out cabinets for light and power	$5,972,000	$3,766,000	$1,847,000
Motors:			
For power—			
Number	244,123	79,877	35,604
Horsepower	1,623,677	678,910	515,705
Value	$18,306,000	$13,121,000	$7,551,000
For automobiles—			
Number	2,796	1,819	3,017
Horsepower	12,471	19,907	8,220
Value	$294,000	$153,000	$192,000
For fans—			
Number	199,113	102,535	97,577
Horsepower	178,033	30,796	12,766
Value	$2,451,000	$1,168,000	$1,055,000
For railways, elevators, and miscellaneous services, including supplies and parts—			
Number	58,698	22,113	23,582
Horsepower	859,237	763,399	684,791
Value	$11,036,000	$7,929,000	$10,707,000
Storage batteries, including parts and supplies.			
Weight of plates in pounds	23,119,331	16,113,073	.....
Value	$4,678,000	$2,646,000	$2,560,000
Primary batteries including parts and supplies:			
Number	34,333,531	8,823,162	2,654,715
Value	$5,934,000	$1,598,000	$1,119,000
Arc lamps:			
Number	123,543	195,157	158,187
Value	$1,707,000	$1,574,000	$1,828,000
Incandescent lamps:			
Carbon filament, tantalum, tungsten lamps	$13,839,000	$6,308,000	$3,442,000
Decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc. (also includes glower lamps and parts, and vacuum and vapor lamps)	$1,876,000	$645,000	$73,000
Sockets, receptacles, bases, fuses, etc.	$5,524,000	$2,879,000	.....
Electric lighting fixtures of all kinds	$6,128,000	$3,295,000	$3,751,000
Telegraph apparatus	$1,957,000	$1,111,000	$1,642,000
Telephone apparatus	$15,547,000	$15,864,000	$10,612,000
Insulated wires and cables	$50,338,000	$34,520,000	$21,292,000
Electric conduits	$5,098,000	$2,416,000	$1,066,000
Heating apparatus	$1,954,000	$396,000	.....
Measuring instruments	$7,800,000	$5,005,000	$1,842,000
Engine ignition apparatus	$6,080,000	$678,000	.....
All other products	$46,720,000	$34,387,000	$18,373,000
Custom work, repairing	$5,691,000	$2,799,000	$2,064,000

[1]Includes establishments engaged primarily in the manufacture of products not identified with the electric industries, but incidentally making electrical machinery, apparatus, and supplies, as follows:

	1909.	1904.	1899.
Number	246	128	.....
Value of Product	$22,660,000	$18,742,000	$13,397,000

The Recent Labor Crisis on British Railways.

By H. RAYNAR WILSON.*

In the difficulties resulting from labor troubles in London, the people of England have just had a taste of what might be expected to happen in the event of a successful railway strike, and the seriousness of the conditions produced makes it of particular importance to review the circumstances of the recently attempted railway strike and to examine the causes of the present feeling of unrest among railway employees.

There had been other labor disputes in several cities; prior to the railroad outbreak. One of the most serious of these was that in London. The men at the docks struck and almost simultaneously there was trouble with the bargemen, carmen and draymen, so that not only was there little unloading of ships but the freight that was unloaded together with that handled by the railroads could not be delivered. Every kind of produce became scarce and rose to unusual prices, and advocates of a big navy found delight in pointing out that such conditions were nothing to the state of affairs that would exist in the event of a blockade in war. The situation became so serious and the outlook so dark that the masters freely granted the men's requests, and matters became almost normal after a very anxious week.

For some time there has been a spirit of unrest in Liverpool, principally in the shipping world, and the success of the agitation in London made the men in Liverpool more aggressive. The masters, however, put up a good fight, and after due notice, locked the men out. There was a good proportion of railway-men amongst these, and on the night of Tuesday, Aug. 15, the railway brotherhoods gave notice to the several companies involved that if the locked-out men were not reinstated within 24 hours they would call out all the railway men in the Kingdom. The Government, recognizing the seriousness of the situation, sent for the men's leaders. This delayed the opening of the strike for 24 hours. Nothing came of the conferences and meetings the Government had with the men and with the masters, and on Friday morning, Aug. 18, a strike was begun over the whole of England and part of Ireland. Matters, however, did not reach a climax in Scotland.

It is hardly necessary to give details of what happened. Suffice it to say, that only about one-third of the men responded to the order to strike. The Government stated publicly its determination to protect the food of the people and the transit of the mails and provided for this purpose ample military forces to guard the stations and other vital points on the lines. Some little trouble was experienced on the underground and tube railways of London, but on the whole the metropolis suffered very little. In fact the south of England was but slightly affected. Matters were, however, in a bad state in South Wales and in the North of England; but with the loyalty of two-thirds of the railway employees, the extent of the military and police support afforded and above all the patience shown by the traveling public (who were, on the whole, against the men) the companies would doubtless have worn the men down. The Government, however, persevered in its efforts for peace and eventually, late on the night of Saturday, Aug. 19, an agreement was reached and the strike was called off.

It is important to recognize the causes of all this trouble. The lock-out at Liverpool was a mere detail. There were other reasons, chief among which was the fact that the companies would not recognize the railway brotherhoods.

This latter difference is an old sore, and nearly brought about a general railway strike in November, 1907. The men have four societies or brotherhoods, the chief being the Amalgamated Society of Railway Servants which practically fought the battle alone in 1907, but on the present occasion all the societies have acted together. In the summer of 1907 the Amalgamated Society of Railway Servants formulated an "All Grades Program," the aim of which was to secure an advance of wages and better hours for all grades. Each company was asked to receive a deputation from the society on the subject. In all cases this was declined, and then the society addressed a similar communication to the Railway Companies' Association—an organization of the chairmen and general managers of all British railways. The secretary of the association thereto replied that it had no power to receive such a deputation, and that the members individually were "of the unanimous opinion that no advantage would arise from such a meeting, because there is no misapprehension on the part of the directors as to the nature and the extent of the request put forward by you which has been fully explained in your recent correspondence with the various companies and your speeches which have been reported in the press."

In the meantime, on instructions from the Amalgamated Society of Railway Servants, the men who were members filled up their notices and sent them to the society, and on the refusal of the companies to meet the deputation the notices were presented. They were timed to expire early in November.

It is advisable to note in passing that then, as now, a liberal government was in office; and as it was placed and retained there by labor votes, the men no doubt counted on the Government coming to their assistance and interfering to prevent a strike, especially as the president of the board of trade, under whose control come the railways, was Mr. Lloyd George, now the chancellor of the exchequer. At all events, the Government did not interfere, and Mr. Lloyd George had interviews with the railway directors and officials and with the men. The result was that on the very eve of the declaration of a strike, the railway companies' representatives signed an agreement declaring their readiness to adopt a system of conciliation and arbitration for the settlement of questions relating to the rates of wages and hours of labor of various classes of their employees.

Each railway company then set up conciliation boards, and it should be noted that in the election of the men's representatives fully 95% of the selected candidates were members of the men's societies. This was not due to the extent of the membership, as only about one-third are members, but because of the organized activity of the Amalgamated Society of Railway Servants and other brotherhoods. All questions were first dealt with at sectional or divisional meetings, and were then referred to the central board. In a few cases agreements were reached without arbitration, but on most railways an arbitrator had to be called. Only wages and hours of duty were dealt with, as these were the only items mentioned in the agreement of November, 1907. The exclusion of other questions was one of the present grievances. The terms agreed to improve the positions of some grades of the men in the matter of wages and hours, and while they increased the cost of working—on the London & North Western Ry. it is about $300,000 a year—the companies never demurred, because of the internal peace that was brought.

It will be opportune to here dispose of a point that has been noted in America. Surprise has been expressed that in many grades—porters for instance—the wages paid are less than $5 a week. Naturally the remuneration of these men has passed under the review of the arbitrators, yet on most of the awards no advance is given to any men, and in the few instances where an increase of 25 cents per week is awarded it is given so variously as to suggest that it is to bring the wages paid by this particular company up to the level of its neighbors.

The pay given to the staff of British railways may appear small not only to American eyes but to English speaking people generally. But it must be remembered that the greater part of the railway system is in agricultural districts where living is cheap and laborers working in the trades are satisfied with wages of $3 to $3.50 per week. They come willingly to the railway, not only because of the attractions railways have for all of us at some time or other but for the higher pay ($4 or $4.25). In addition, they receive their uniforms, and from three to seven days annual leave of absence with pay and a free pass on the company's own system. They have also an unlimited number of privilege tickets, whereby they can travel anywhere at one-quarter rate. The rate for porters is from $4 to $4.75 or $5, and they are promoted thence to signalmen (towermen) or to guards or shunters (switchmen) at from $5.25 to $6 per week. Other grades of the service are then open to them. These rates are for the country and are somewhat lower than those paid in towns.

To the wages of the porters must be added the gratuities they receive from passengers. These are contrary to the companies' regulations; but as the officials recognize that they are given and received, being themselves donors of tips, it would be better if instead of forbidding the taking of gratuities, the rule were to read "no gratuity is allowed to be demanded from passengers."

A man entering the British railway service is, as a rule, in it for life. And that he is happy and contented with his lot may be judged from the returns of the brotherhoods. According to the official figures of the board of trade, there were at the end of last year 608,750 men employed on the railways of the United Kingdom. From this number let there be deducted 70,405 clerks, 86,683 mechanics and 25,246 boys and there remain 446,416 men available for membership. Yet there are only 104,485 members in all four societies, and 75,153 are in the Amalgamated Society of Railway Servants. In passing it may be noted that since conciliation boards were established in 1907, the membership of the last named society has decreased by 22,408.

As to hours of duty, it may be noted on the authority of a report of the Amalgamated Society of Railway Servants that 67% of the railway men in the United Kingdom work ten hours and 7% work eight hours, while only 25% are classed as twelve-hour men. It is, practically, the law not to employ men for more than twelve hours.

It may then be asked, now that conciliation boards have been established where wages and hours are agreed to, what the present trouble can be? The answer generally given to this is that the boards work too slowly and that the companies put all sorts of difficulties in the way. Possibly this is true, as it is only natural that the officials are not keen to incur the extra expense that follows any change—the chairman of the Great Western Ry. said that an increase of 25 cts. per week for each member of their staff would add over $900,000 to the pay-roll. Some light on this may be gathered from the following extract from a letter signed "Watchman" that appeared in bold type in the London "Times" headed "The Railwaymen's Case."

The conciliation boards have never worked well. They are badly constructed, are full of flaws and leave the men at a disadvantage. The railway companies—who did not want the boards, be it said—observe them in the letter, but not in the spirit. Every smart young understrapper on the railways knows that the surest way to promotion is to devise minor evasions of the scheme. Thus, a policy of pinpricks has been set in motion. The men know that collectively their grievances, if stated baldly to the public, might not seem to amount to much, but they suffice to produce far more exasperation than a policy of heavy oppression. Again, the men feel a difficulty in stating their case. The spokesman becomes a marked man and upon the slightest dereliction is discharged.

These are points that will shortly be cleared up, as the Government has appointed a royal commission to enquire and report promptly as to the working of railway conciliation boards.

It is, however, to be feared that under all this lies a determination on the part of the brotherhoods that they shall be recognized as the mouthpieces of the men. The companies are equally determined to the contrary. Many deep-thinking men see no reason why railways should not adopt the methods in force in other trades. But the companies have three good answers to this. They

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point to the figures already given, which on the very best showing only give the brotherhoods one member in every four. They quote the North Eastern Ry., which in 1897 recognized the Amalgamated Society of Railway Servants and has had more trouble since then than all the other companies put together, and on whose line the recent strike lasted three days longer than on the other systems. Finally they point out that there is a tendency for the men to ignore their leaders.

In the meantime in the face of the common foe, the companies have been brought still more closely together. For the last three years, combinations, community of interests and a general abolition of competition have been the order of the day among British railways with the result that they have effected great economies of operation. The increased net receipts have not all gone in dividends but in part to reserve funds for strengthening the track and bridges and renewing rolling stock, so making the lines of greater value and incidentally making the nationalization of the railways more difficult of accomplishment.

The latter question is again prominent as a consequence of the railway unrest. Moreover, it will increase in force because one of the conditions laid down by the companies and accepted by the Government was that the latter would secure the necessary Parliamentary powers affirming that the increased cost of working, due to improved conditions for their staff, would be justification for railway companies to increase their rates accordingly. This is a feature that is not to the liking of the trader.

A Hotel Fire at Juneau, Alaska, Sept. 3, destroyed the Juneau Hotel and the McGrath Bldg., and according to press reports caused the deaths of eleven persons. Six bodies were recovered from the ruins.

Fire Destroyed the Large Smelting Plant of the Hall-of-Mines Smelter Co., near Nelson, British Columbia, Sept. 3, with a loss estimated at $750,000.

Panama Canal Excavation during August totaled 2,706,223 cu. yds., a daily average of 100,230 for the 27 working days. The amount of concrete laid during the month was 149,717 cu. yds. and 613,820 cu. yds. of fill was placed in dams. The rainfall for August was 7.79 ins.

A Premature Blast in a stone quarry near Elmhurst, Ill., Sept. 9, killed four men and badly injured two others.

A Theater Collapsed at Nice, France, Sept. 8, during extensive repairs. Forty workmen were buried in the ruins and 16 of these were dead when taken out.

An Altitude Record for aeroplane flight of 13,940 ft. was made by R. C. Garros at Parame, France, on Sept. 4.

A cross-country flight from New York City to the Pacific Coast was started on Sept. 13 by J. J. Ward, using a Curtiss biplane equipped with two 50-HP. engines. R. G. Fowler, who started a cross-country flight from San Francisco on Sept. 12, reached Auburn, Cal., on the first day, having covered 118 miles. After going some 40 miles further on the second day, and when close to Alta, Cal., his steering gear became damaged and, in attempting to land, the machine was tangled in a tree. The aviator was severely bruised and the machine badly damaged.

Two military aviators were killed in France on Sept. 2. Lieut. de Grailly was making a flight from Troyes to Paris when his fuel tank exploded. He was badly burned and crushed by the fall of the machine. While Capt. de Carmine was making a flight, preliminary to a cross-country trip, the right wing of his machine came loose and he was dropped some 600 ft., crushing his skull.

A French aviator, Leforresier, was killed on Sept. 4, at Huelva, Spain, by a fall. On Sept. 7, Lieut. Newmann, of the German Army, and his passenger, a French aviator named Leconte, instructor in an aviation school at Mülhausen, were killed in a fall at Bilzheim after their fuel tank had exploded. A Peruvian aviator, Carlos Tenaud, died at Lima, Peru, on Sept. 7, as the result of a fall of last spring.

A Floor of a Reinforced-Concrete Building, under construction at Winnipeg, Man., collapsed on Sept. 7, and caused the death of one workman and the injury of several others. The building, the property of the Canadian Fairbanks Co., had reached the fourth floor, and from the meager reports now available it seems that the forms under this floor had been removed prematurely, so that it collapsed. The injured men were on the third floor, which held under the impact of the falling material. We expect further information regarding the details of the construction and of the accident.

A New 12,000-KW. Steam Power Station of the Minneapolis General Electric Co., replacing the one destroyed by fire on Jan. 6, 1911, (see Eng. News, Jan. 12, 1911, p. 59) has recently been completed by the Stone & Webster Engineering Corporation, and has been turned over to the company. The site of the old Main St. station is occupied by a large distributing station, the new steam plant being erected on the Mississippi River, north of the city. Ground was broken on Feb. 25 and current was furnished on Aug. 1; the plant has turbine units housed in a steel and brick structure. The new distributing station receives current from the steam plant and from the Taylor's Falls transmission line, and also generates 1,200 KW. by wheels taking water from the Mississippi River. A new substation, at Sixth St., and several miles of underground transmission lines were a part of the work of reconstruction.

A Machine Tool for Acetylene Welding and cutting which has been recently put on the market is designed to make rectilinear welds and cuts in sheet metal. It may be used for welding sheets up to about 3/16-in. thick. The general plan of the machine is to move a specially designed oxy-acetylene torch along a straight guide bar by means of a lead screw, with the work attached to a suitably arranged table below. The guide bar is made in the form of a hollow cylindrical shaft 3 or 4 ins. in diameter and about 7 ft. long. This shaft projects horizontally from a vertical column 8 or 10 ins. in diameter and 6 ft. high to which it is attached by means of a clamp socket or collar. The height of the guide bar can be adjusted by means of a hand crank acting through a rack and pinion gearing on the collar. The work table extends along the floor from the base of the vertical column out under the guide bar, so that the machine somewhat resembles a radial drill.

The lead screw is placed parallel to the guide bar and is a few inches directly above it. It engages a nut on the torch holder, which is clamped with a sliding fit to the guide bar. The holder is so arranged that the torch can be swiveled to the desired angle with the work and clamped in position. Oxygen and acetylene are brought to the torch through flexible tubes. The machine is being put on the market by the Davis-Bournonville Co., of 90 West St., New York City.

Electric Interurban Trains of the Aurora, Elgin & Chicago Ry. enter Chicago over the Garfield Park line of the Metropolitan Elevated Ry., and during the rush hours these through trains (which make only one stop on the elevated line) are often delayed considerably by having to follow Metropolitan Ry. trains which stop at every station. From the downtown terminal station (at Fifth Ave.) to Marshfield Ave. there are four tracks, and the interurban trains use the same tracks as the express trains of the elevated line. But beyond this there are only two tracks, and although a third track has been proposed this would involve expensive construction work and rearrangement of stations. To reduce the delays, however, a run-around or by-pass arrangement has been made at about the middle of the line, by which an express train can pass a local train standing at the St. Louis Ave. station. A double crossover connects the two tracks near each end of the station, and these are equipped with a complete switch and signal interlocking plant operated from a tower at the station. When a westbound slow train is closely followed by a through interurban train, the former is held at the station and eastbound trains are stopped by signal beyond the limits of the interlocking, so that the through train is diverted to the eastbound track in passing the station and then returned to the westbound track. The length of crossover between switches is about 140 ft., and No. 7 frogs are used.

Personals.

Mr. Arthur P. Noyes has been appointed City Engineer at Vallejo, Cal.

Mr. J. H. Black has resigned his position as Superintendent of the Temiskaming & Northern Ontario Ry., with headquarters at North Bay, Ont., to become General Manager of the Northern Ontario Light & Power Co., at Haileybury, Ont.

Mr. J. P. Snow, M. Am. Soc. C. E., has opened an office for engineering practice at 18 Tremont St., Boston, Mass., Room 1120, instead of at West Somerville, Mass., as noted in this column Sept. 7. Mr. Snow's residence is at West Somerville.

Mr. Wm. R. Benson, Chief of the Bureau of Highways and Street Cleaning of Philadelphia, Pa., with a salary of $6,000, has been dismissed by Mayor Reyburn for "disloyalty to the administration," as the result of a political disturbance.

Mr. Geo. R. Stearns, Director of Public Works of Philadelphia, and Mr. Wm. R. Knight, Assistant Director of the same department, have also been dismissed by the Mayor. Mr. Stearns' salary was $10,000 per year and Mr. Knight's was $4,000.

Mr. John E. Sweet, Past-President Am. Soc. M. E., President of the Straight Line Engine Works, of Syracuse, N. Y., will sail from New York City, Oct. 21, with his wife, for a trip around the world. He plans to land in San Francisco Feb. 1, 1912.

Mr. Frederick Van Z. Lane, who has held for several years the position of Engineer in Charge of Bridges of New York City with a salary of $4,000 per annum, has been dismissed from the bridge department by Commissioner O'Keefe. The position has been abolished.

Mr. H. B. Pulsifer, M. Am. Inst. M. E., recently on the staff of the United States Reduction, Refining & Smelting Co., at Murray, Utah, has taken a position as an instructor at the Armour Institute of Technology. Mr. Pulsifer is a graduate of the Massachusetts Institute of Technology.

Mr. W. C. Hurst has resigned his position as Superintendent of the Toledo division of the Cincinnati, Hamilton & Dayton Ry. in order to devote his attention to personal interests in California, whither he will go with his family from Dayton, Ohio. His resignation is to take effect Sept. 30.

Mr. F. Ringer, recently Principal Assistant Engineer of the Missouri, Kansas & Texas Ry. Co., at Parsons, Kans., has been made Assistant Chief Engineer with headquarters at St. Louis, Mo. His former position has been abolished, but Mr. R. M. Garrett, formerly Resident Engineer at Sedalia, Mo., has been made District Engineer with headquarters at Parsons, Kans. Mr. Garrett's former position has been abolished.

Mr. Harold Parker, M. Am. Soc. C. E., Chairman of the Massachusetts State Highway Commission, has sent his resignation to Governor Foss, to take effect Nov. 1. Mr. Parker is a graduate of Harvard University and was for many years engaged in railway and contracting work. He has been a member of the Massachusetts Highway Commission since 1900. Mr. Parker, it is reported, has been made a Director and Vice-President of the Hassam Paving Co., of Worcester, Mass., and will have general charge of that company's contracts in this country and Canada.

Obituary.

Masuchika Shimose, inventor of the "Shimose" powder, adopted in 1893 for use in the Japanese Navy, died Sept. 6 at Tokio, Japan, aged 52 years.

Thomas E. Crimmins, a contractor on excavation work and sewer construction in New York City, died Sept. 8 at his home in that city after an illness of more than a year's duration.

Olin A. Stranahan, M. Am. Soc. M. E., died Sept. 8 at a dentist's office in New York City, while undergoing an operation for an absessed tooth. Mr. Stranahan was for many years General Sales Agent for the Allis-Chalmers Co. He was buried Sept. 11 at Litchfield, Ohio.

Lemuel R. Hopton, member of the Illuminating Engineers' Society and Superintendent of the Enos Co., of New York City, manufacturers of lighting fixtures, died Sept. 5 at Garrison-on-the Hudson, N. Y. He was born in New Haven, Conn., in 1874 and was a graduate of the Sheffield Scientific School in the class of 1896. His course was mechanical engineering. Mr. Hopton had resided for the past ten years at Plainfield, N. J. He is survived by his wife and two children.

Alfred J. Bettles, a member of the Mining and Metallurgical Society of America, died Aug. 3 from complications following an operation. He

was born in England 55 years ago, moved to Ontario, Canada, when a young man and from there went to Colorado and later to Montana, where he established himself as a mine operator and metallurgist. The last 14 years of his life were spent in Utah, with Salt Lake City as headquarters. He is survived by his widow and four children.

Wm. B. Hixson, Superintendent of Bridges and Buildings of the Delaware, Lackawanna & Western R. R., was found dead in his office at Scranton, Pa., Sept. 10. A coroner ascribed his death to suicide by a revolver shot. Mr. Hixson was born July 24, 1850, in Harrison Co., Ohio, and received his education in the common schools. He began work as an apprentice bridge raiser for the American Bridge Co. in 1869 and subsequently had charge of the erection of many bridges in the western states for several of the large bridge companies. He had been a superintendent of bridges and buildings for various railways since 1877 and had held this position with the Delaware, Lackawanna & Western R. R. since April, 1899.

William Bremner, a pioneer settler and engineer of Iowa, died in Iowa City, Iowa, on Aug. 29, at the home of his daughter. He was born in Scotland in 1831, and while a very small child came with his parents to this country and settled in New England. As a young man Mr. Bremner was engaged in survey work on some of the earliest railways in Connecticut. In 1856 he moved to Marshalltown, Iowa, and took up the practice of law, for which his earlier education had fitted him. The attractions of the out-of-door life of a surveyor, however, not long afterwards induced him to abandon his law office, and again take up the practice of surveying. In 1865 he was elected County Surveyor, and year after year he was re-elected until, in the spring of 1910, he resigned his office after 45 years of consecutive service. During almost all these years he had also served his home city of Marshalltown as City Engineer. To this office he was elected in 1863 and served continuously until 1905. Mr. Bremner celebrated the 50th anniversary of his marriage to Miss Kate Hampton, of Marshalltown, on May 24, 1910. Besides his widow, he leaves two sons, Geo. H. Bremner, of La Grange, Ill., and William H. Bremner, General Attorney of the Minneapolis & St. Louis and Iowa Central Rys., and one daughter, Mrs. O. A. Byington, of Iowa City.

William Dana Taylor, Chief Engineer of the Chicago & Alton and the Toledo, St. Louis & Western Rys., died Aug. 26, at his residence in Chicago. Mr. Taylor's intimate friends have known for some time that he was suffering from a hidden malady. The readers of Engineering News will recall Mr. Taylor's notable paper on the work of students in the engineering schools, published in our issue of May 11, 1911. In a personal letter to the editor accompanying the manuscript of that paper, Mr. Taylor explained that the paper was one which he had delivered as an address before the students of Purdue University and had expected to use in similar addresses elsewhere. His physicians had informed him, however, that there was little chance that he would be able to use his voice any more in public speaking, and he therefore thought best to offer the manuscript for publication. From other sources we were informed a short time later that the malady was one which threatened not only his voice, but his life.

Mr. Taylor was a comparatively young man, having been born in Montgomery, Ala., fifty-two years ago. He was a graduate of the Alabama Polytechnic Institute, where he studied civil engineering, and he did post-graduate work at Johns Hopkins, Cornell and Chicago Universities. Shortly after his graduation, in 1881, he was engaged on surveys for the Mexican Central R. R. He spent a considerable time in the Engineering Department of the Louisville & Nashville system, and had charge for that company of the construction of the Alabama Mineral and Birmingham Mineral Rys. in Alabama in the late '80's. In 1891 he began teaching engineering, holding the chair of civil engineering at the Louisiana State University for five years. During the Spanish War he received a commission as Captain of the Third United States Volunteer Engineers. After the war he was appointed Chief Engineer of the St. Louis, Peoria & Northern Ry. For five years previous to 1906 he held the chair of railway engineering at the University of Wisconsin, and did notable work in connection with the appraisal of Wisconsin railways for the State Commission. He resigned his professorship in 1906 to become Chief Engineer of the Chicago & Alton Ry., and was later made Chief Engineer also of the Toledo, St. Louis & Western Ry., the Minneapolis & St. Louis and the Iowa Central Rys. Mr. Taylor was elected to membership in the American Society of Civil Engineers in 1899, and was also a member of the Western Society of Engineers, the Society for the Promotion of Engineering Education, the American Railway Engineering Association and the Engineers' Club of Chicago.

For a dozen years Mr. Taylor had been a frequent and valued contributor to the columns of Engineering News. He was an original thinker, a forceful writer and a man of high ideals. Knowing the shadow that hung over his life, one can understand better the tinge of pessimism discernible in his last contribution to our pages, which aroused so much attention and discussion. One can appreciate all the more, also, his earnestness in sounding a warning against what he believed to be prevailing evils in our system of higher education.

Engineering Societies.

COMING MEETINGS.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 19-21. Annual convention at Spring Lake, N. J. Secy., N. T. Wilcox, Lowell, Mass.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Sept. 19-22. Annual convention at Milwaukee, Wis. Secy., James McFall, Roanoke, Va.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 21-23. Annual meeting at Toronto, Ont. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting at Kalamazoo, Mich. Secy., Julius Bordollo, Kingsbridge, New York City.

MICHIGAN GAS ASSOCIATION.
Sept. 20-22. Annual meeting at Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-28. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-28. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Sept. 26-29. Annual session at Chicago, Ill. Secy., J. F. Callbreath, Denver, Colo.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C., Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10-17. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Annual convention at St. Louis, Mo. Secy., C. A. Lichty, C. & N. W. Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 18-20. Annual convention at St. Louis, Mo. Secy., A. B. Beadle, 29 West 39th St., New York City.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Nov. 2-4. Annual meeting at Cincinnati, Ohio. Secy., Edward H. Reisner, 20 West 44th St., New York City.

Western Society of Engineers.

At the regular meeting held Sept. 6 at Chicago, Ill., Mr. W. C. Armstrong presented a paper on "The New Passenger Terminal of the Chicago Northwestern Ry."

Central Railway Club.

The annual fall outing, which was held at Buffalo, N. Y., Sept. 8, included a boat ride, a dinner and a business session. Mr. J. P. Murphy, of Collinwood, Ohio, presented a paper on "Conservation of Waste in Railway Stores."

Pennsylvania Electric Association.

At the fourth annual convention at Exposition, Crawford Co., Pa., Sept. 5-8, officers for the ensuing year were elected as follows: President, R. S. Orr, of Pittsburgh; Vice-President, Van Dusen Rickert, of Pottsville; Treasurer and Secretary, Walter E. Long, of Philadelphia.

American Institute of Chemical Engineers.

The fourth annual meeting will be held at Washington, D. C., Dec. 20-22. Papers will be presented on the general subject of patents and on the manufacture and testing of explosives. Visits will be arranged to industrial chemical plants in Baltimore and vicinity and to laboratories and other points of interest in Washington. The secretary is Mr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

American Association for Highway Improvement.

This association has received notice from the Permanent International Association of Road Congresses that it will be recognized as the United States correspondent of the international association. An effort is to be made to bring the international congress to America in 1915. The 1913 congress will be held in London, England. At the congress of the American Association, to be held at Richmond, Va., Nov. 20-23, 1911, a meeting of manufacturers of road machinery and materials will be held with the object of forming an organization to cooperate with the Association.

Illuminating Engineering Society.

The program of papers to be presented at the fifth annual convention at Chicago, Ill., Sept. 25-28 has been announced as follows: Presidential Address on "The Relations of Physico-Physiological Research to Illuminating Engineering," Dr. A. E. Kennelly; Report of Committee on Nomenclature and Standards, A. J. Humphries, Chairman; Report of Committee on Progress, Dr. Louis Bell, Chairman; "Symposium on Illuminating Glassware," Bassett Jones, Jr., A. J. Marshall, L. W. Young and G. H. McCormack; "The Manufacture of Glass from the Viewpoint of the Illuminating Engineer," E. H. Bostock; "An Analysis of the Requirements of Modern Reflector Design," F. L. Godinez; "Recent Small Gas Lighting Units," F. H. Gilpin; "Natural Gas, Its Production and Utilization," G. S. Barrows; "Recent Developments in the Manufacture of Incandescent Lamps," J. E. Randall; "The New Quartz-Tube Mercury Arc Lamp," Geo. C. Keech; "The Law of Conservation as Applied to Illumination Calculations," Dr. A. S. McAllister; "The Photometry of Large Light Sources," Geo. H. Stickney and S. L. E. Rose, "Photometry at Low Intensities," Dr. Louis Bell; "Evaluation of Lamp Life," P. S. Millar and L. J. Lewinson; "Distribution of Luminosity in Nature," Dr. H. E. Ives and M. Luckiesh; "Resume of Legislative Enactments on Illumination," E. L. Elliott; "Selling Illumination," F. B. Rae; "Influence of Surroundings and Lighting Systems on the Illumination Required," J. R. Cravath; "Relation of Shadow to Relief Design," Bassett Jones, Jr.; "Flames Carrying Electric Current," C. F. Lorenz; "Influence of Light Distribution Upon Illuminating Efficiency and Visual Acuity," A. J. Sweet.

American Society of Municipal Improvements.

The headquarters for the 18th annual convention at Grand Rapids, Mich., Sept. 26-29, will be the Pantlind Hotel. Among the papers to be presented are the following: "The Municipal Water-Purification Plant at Grand Rapids," George W. Fuller; "The Sewage Disposal Experiments Conducted by the Sanitary District of Chicago," Langdon Pearse; "Some Examples of Ornamental Street Lighting," Joseph E. Putnam, Assistant City Engineer, Rochester, N. Y.; "Maintenance and Development of Parks," H. S. Richards, Assistant Superintendent, South Park Commission, Chicago; "Bituminous Concrete Pavements," H. G. Lykken, City Engineer, Grand Forks, N. Dak.; "Notes and Queries on Grouted and Sand-Filled Brick Pavements," Maury Nicholson, City Engineer, Birmingham, Ala.; "Some Observation in Matters of Contraction and Expansion of Vitrified Brick Street Pavements," Will P. Blair, Secretary, National Paving Brick Manufacturers' Association.

Committee reports will be presented by the various subcommittees of the committee on standard specifications. The subjects of these reports will be wood-block paving, brick paving, bituminous-paving nomenclature, asphalt paving and sewer specifications. Members of these committees will meet at the Pantlind Hotel at 10 a. m., Sept. 25, to draw up their final reports. All those interested in specifications for paving or sewers are invited to be present at this meeting. In connection with the convention there will be an exhibit of municipal appliances. Entertainments to be given the society by the city will include a trolley ride around the city, a banquet and an automobile ride to inspect work being done by the municipality.

In accordance with a resolution adopted at the last convention, President Giddings has appointed 15 members to represent the society at the International Municipal Congress and Exhibit which is to be held at Chicago, Ill., Sept. 18-30.

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